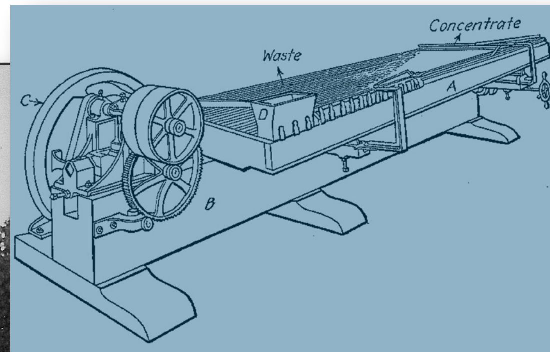
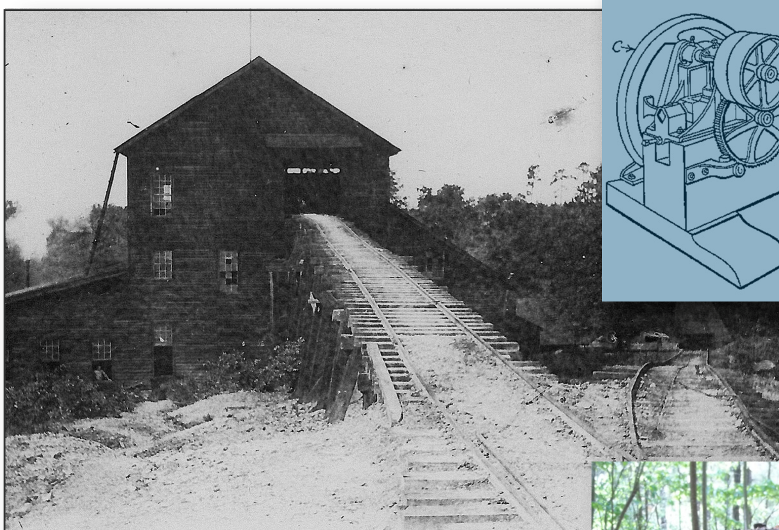
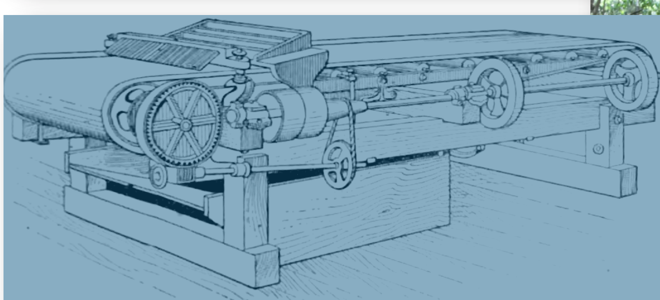
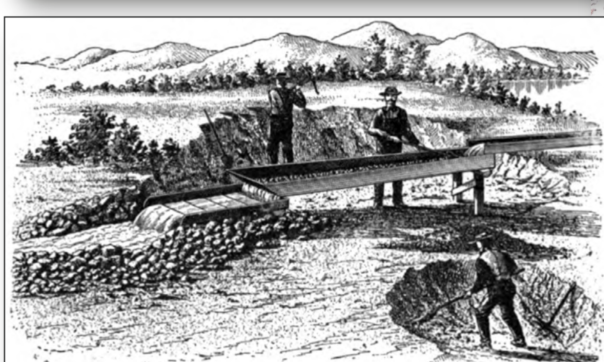
History and Archaeology of the Haile Gold Mine Stamp Mill (Site 38LA383)

Lancaster County, South Carolina









NEW SOUTH ASSOCIATES

PROVIDING PERSPECTIVES ON THE PAST

History and Archaeology of the Haile Gold Mine Stamp Mill (Site 38LA383)

Lancaster County, South Carolina

Report submitted to:

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ABSTRACT

Site 38LA383 represents the stamp mill complex associated with Haile Gold Mine, a nineteenth- to twentieth-century mining operation near Kershaw in Lancaster County, South Carolina. During World War I, the site was also used for processing pyrite ore, after which it was abandoned. Gold Mining at the site recommenced for a period between the wars but the stamp mill site was not reused. In association with planned resumption of gold mining by Haile Gold Mine, New South Associates has conducted a historical and archaeological data recovery of 38LA383 to partially mitigate the effects of the planned mining on and adjacent to the site. As per an agreement with South Carolina Department of Archives and History, the data recovery project represents one stage of the mitigation, the other being an archaeological context of gold mining in the Carolinas. This report provides the results of the historical and archaeological study of 38LA383.

Historical research for the present study provided information about the development of Site 38LA383 and the overall history of Haile Gold Mine. Additionally, research provided a context for understanding how the stamp mill operated within the broader mining operation. The historical study documented the significance of Haile Gold Mine during the nineteenth century. Although the site is now remembered primarily for the disastrous boiler explosion in 1908 that killed the mine supervisor Ernst Thies, wrecked the stamp mill, and led to end of gold mining operations for several years, Haile was also the site of important technical experimentation and innovation in gold mining. In particular, Thies' father, Carl Thies, developed a streamlined system of chlorination here. Chlorination was a chemical treatment for extracting gold from sulfide ores. Thies' improvements not only made Haile among the most productive eastern gold mines between the 1880s and early 1900s but also provided the site with considerable renown within the field of mine engineering.

Archaeological study focused on the stamp mill (Site 38LA383), established during the 1880s by Carl Thies' predecessor, E. Gybbon Spilsbury, and expanded by Thies after he became supervisor in 1888. The mill was the only extant portion of the historic mining operation, the rest of the site having been destroyed by mid-twentieth-century operations. Archaeological fieldwork documented remains of the stamp mill, concentration shed, engine room, and boiler house, as well as elements of the mine's small-gauge railroad, a reservoir, and workers' house. The site occupied a prominent ridge and terraces of Haile Gold Mine Creek, and fieldwork involved documenting features and mapping their relationship to the local terrain. The purpose of the stamp mill was to reduce the size of the gold-bearing ore to extract free gold and then concentrate the residual ores for further processing at the chlorination plant. Later, the mill was remodeled to process pyrite ores, which involved crushing, grinding, and concentration for shipment to sulfuric acid plants located elsewhere in the country. Analysis of the site illustrated the way the mill designers arranged the complex to utilize certain features of the terrain, particularly the drop in elevation from the ridge crest to the stream terraces. This allowed the mill to use gravity to move materials down and forward during the milling process. A surprising find was the apparently insubstantial foundations

used to support the mill. Stamp mills were subject to significant weight and vibrations and required solid foundations. At 38LA383, however, the mill appeared to be held up on wood pilings. No heavy building foundations were observed.

Similarly, the railroad ramp to the mill's third floor was supported on relatively insubstantial cement footings that did not appear solid enough for regular use by a multi-ton train. In addition, the cement footings and molds of the associated wood posts exhibited variation in size, shape, and construction. This suggested a haphazard rather than systematic process of installation. Inspection of brick piers associated with a workers' house also revealed variation in size and shape, and implied that the piers could represent piecemeal replacements. These findings gave rise to questions about how the mine's supervisors approached construction and maintenance of facilities and if the situation seen at this site was typical of mining operations in the region.

As a result of this data recovery project, the developmental history, function, and structure of Site 38LA383 were delineated. The site's place within the broader operation of Haile Gold Mine was described, and baseline data was generated for comparisons with other sites. The results of documenting 38LA383 will therefore contribute to productive identification, evaluation, and archaeological study of gold mining in the Carolinas.

ACKNOWLEDGEMENTS

This archaeological project required the assistance and cooperation of numerous individuals. Foremost, Ramona Schneider, Environmental Manager at Haile Gold Mine, facilitated our fieldwork and helped arrange access and the use of equipment. We also greatly appreciate the efforts of the equipment operators who cleared the site and conducted the backhoe excavation.

For New South Associates, Natalie Adams served as Project Manager and Principal Investigator. Mark Swanson was the Project Historian and prepared the history of Haile Gold Mine and its operation. Project Archaeologist Brad Botwick directed the fieldwork with the assistance of Sarah Lowry, Scott Morris, and Sarah Smith. Sarah Lowry surveyed and prepared the maps of the site. Scott Morris performed the artifact analysis under the supervision of Laboratory Director Amy Vest. Tom Quinn and David Diener prepared graphics for this report and Rebecca Brown provided editorial and production assistance.

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I. INTRODUCTION

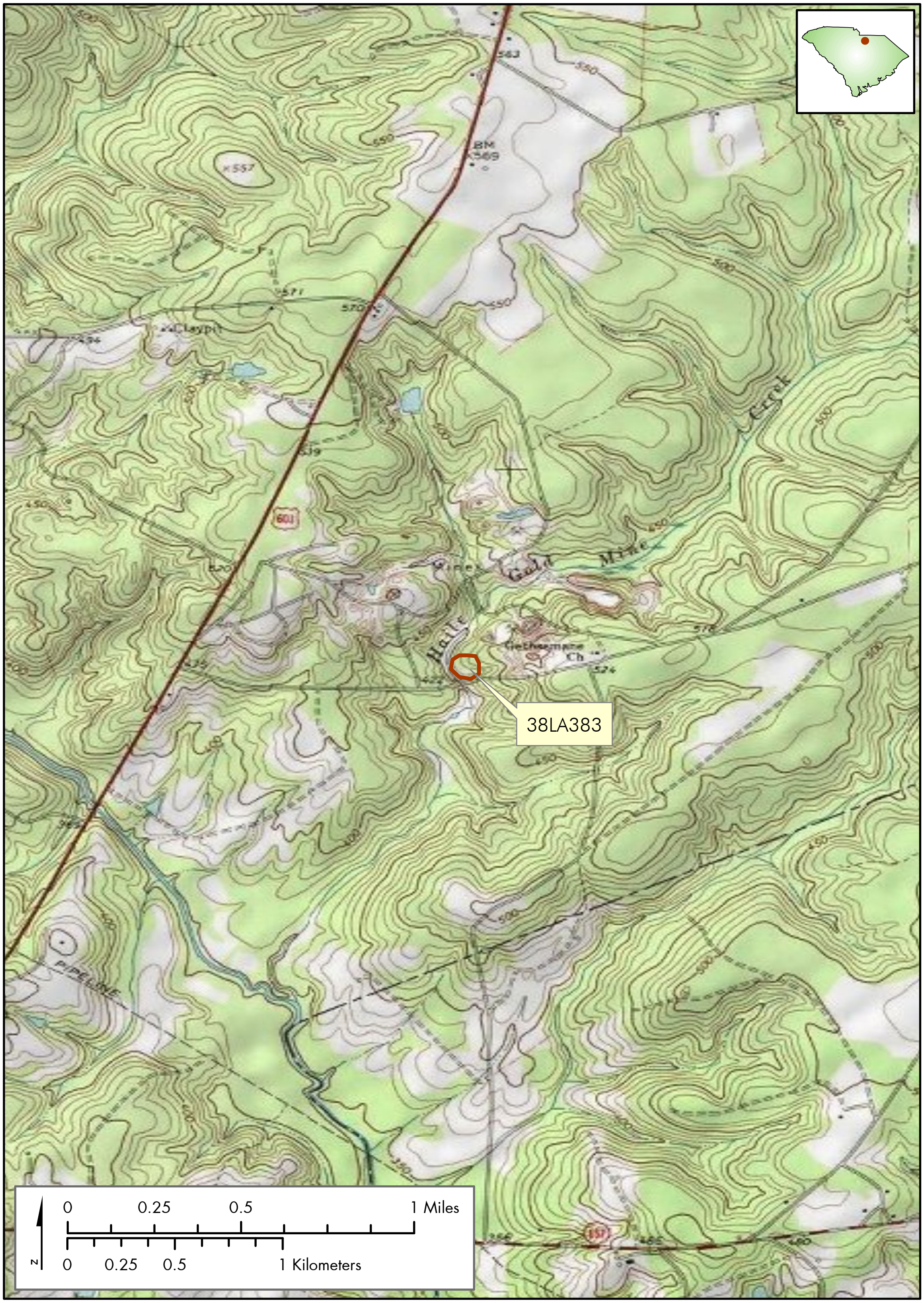
The Haile Gold Mine comprised a nineteenth- to twentieth-century mining operation that was notable as one of the most productive gold mines in the southeastern United States. The site was also where mining engineer Carl Thies developed the barrel chlorination process for extracting gold from the ores, an advance that was considered one of the significant improvements to the chlorination process. Gold mining took place at and around Haile Gold Mine throughout the nineteenth century at varying scales and with diverse techniques. In the last quarter of the century, the site developed into a highly industrialized operation containing a complex of open pit and underground mines, ore dressing facilities, offices, conveyors, railroads, and a mill village with a post office, school, and church. Among the ore processing components of this complex was a stamp mill for crushing gold-bearing ore, separating out the free gold, and preparing the crushed ore for further processing. The stamp mill ran from the 1880s until 1908 when the plant's boiler exploded and contributed to the end of operations. During World War I, the stamp mill was remodeled to process pyrite for sulfuric acid manufacture. Although gold mining continued on the property after pyrite operations stopped, the stamp mill was mostly unaffected by the later work, leaving a complex of archaeological features designated Site 38LA383, that comprises the only known remnant of the late nineteenth- to early twentieth-century mining complex.

Southeastern Archaeological Services (SAS) recorded remains of the stamp mill on Haile Gold Mine (Ledbetter) Creek during a 1993 survey (Figure 1). SAS described the site as encompassing masonry piers, rock walls, a possible subsurface feature outlined by masonry, and wooden piling remnants. Limited shovel testing and surface collection yielded ceramics, bottle glass, brick, and metal hardware. Based on the surface finds, SAS recommended the site as potentially eligible for the National Register of Historic Places (NRHP) because of its association to gold mining in South Carolina (Pluckhahn and Braley 1993).

Modern gold mining operations took place at the Haile Gold Mine from 1985 to 1991 with exploration and feasibility studies continuing after mining had ceased. Closure activities, including reclamation of modern mining and pre-modern mining facilities, continued until 2006. Beginning in 2007, the property came under new ownership that reinitiated exploration and feasibility studies to renew the production of gold using modern mining and recovery processes (Hulse et al. 2008:1; Romarco Minerals, Inc. 2008). As part of the environmental mitigation for this proposed mining activity, Haile Gold Mine undertook a series of archaeological surveys, evaluation studies, and data recovery projects. The present data recovery project comprises one such study.

No Phase II evaluation of Site 38LA383 was completed to definitively determine its historical and archaeological significance. Instead, Haile Gold Mine opted to accept that the site was NRHP eligible and mitigate the effects of potential future mining operations on it or in its vicinity. The data recovery approach was characterized as "creative mitigation" in that the South Carolina State

Figure 1.
Site 38LA383 Location



Source: 1917 USGS Kershaw, South Carolina Quadrangle

Historic Preservation Office (Department of Archives and History) agreed to substitute the preparation of a historic context for extensive and detailed excavation. The mitigation emphasized mapping and recording structural remains and limited excavations combined with detailed historical research. This report describes the results of the work conducted at Site 38LA383.

RESEARCH DESIGN

This present mitigation project concentrated on the stamp mill complex of the late nineteenth century Haile Gold Mine plant, designed Site 38LA383. Historic maps and photographs indicate that the stamp mill consisted of four contiguous buildings: the stamp mill, the concentration shed, the engine room, and the boiler house, as well as a small-gauge railroad and associated facilities. This complex of buildings and structures operated until the boiler explosion on August 10, 1908. During World War I, the stamp mill was remodeled to handle pyrite ores and operated in this capacity from about 1917-1919. In the years that followed, work continued at Haile Gold Mine but not at the stamp mill location.

Site 38LA383 contains several aboveground structures that were described in a 1977 National Register Nomination Form (Zagareli 1979) as well as by Pluckhahn and Braley (1993), who first recorded the remains as an archaeological site. No detailed archaeological investigation of the site had been conducted before the present mitigation study. Due to previous interest by the State Historic Preservation Office regarding this site, Haile Gold Mine decided to proceed to the data recovery phase without conducting a Phase II study. The data recovery research design was therefore based on a limited understanding of the site. Accordingly, the research topics for this report focused primarily on understanding the structure of the site and how the individual features related to one another as part of a functioning system. Archaeological work conducted at Reed Gold Mine in Cabarrus County, North Carolina, suggested questions that were applicable at 38LA383. At the Reed Gold Mine engine house (31CA18**1), Trinkley (1986) was interested in examining the architectural components of the site and understanding the ore processing procedures of the site by studying the arrangement and construction of features. A final concern of that study was the lifeways and economic status of the miners.

Trinkley (1986) was partially successful in meeting his research goals. His first topic, to identify architectural components of the engine house was addressed with the exposure of numerous features representing stone exterior and internal wall foundations, possible equipment mounts, and a boiler pit. Stratigraphic evidence indicated a sequence of construction episodes that Trinkley thought corresponded to documented cycles of mining activity. Trinkley's question concerning the ore processing methods was addressed with the discovery of a stone platform interpreted as a Chilean mill bed. Analysis of tailings samples indicated extremely high levels of mercury, indicating the amalgamation process. Trinkley (1986:83) recommended plotting soil and slurry types as an alternative to particle size analysis as a means of identifying different activity areas.

Little information was found at the Reed Gold Mine engine house to indicate the lifeways and socioeconomic status of the miners. The workplaces would be expected to yield little information on this topic and Trinkley's study area did not include workers' housing.

Based on Trinkley's (1986) study, New South posed three site-specific research questions that could be addressed by the historical research and archaeological efforts proposed for this mitigation (Adams 2010:4):

1. What are the physical components of the pre-1908 stamp mill, which included the stamp mill itself, the concentration house, and the boiler and engine rooms? How did these components function together?

2. Was there evidence of changing technology at the stamp mill?

3. The first stamp mill at Haile Gold Mine was a five stamp mill constructed in 1837, but the location of this mill is not known. Was it at site 38LA383 or somewhere else?

Addressing these questions and providing a historical context for Haile Gold Mine was especially important for this study because much of the Haile mining operation has been lost and reconstructing how it functioned, as well as understanding the role of the stamp mill, required reference to archival sources. The archaeological aspect of the study emphasized recording the actual substance of the stamp mill, its scale, and arrangement. As Hardesty (1988:108-109; 2010:22) has noted, documents provide important information on sites but often do not provide details about more mundane elements of a mining operation, such as auxiliary structures and activities, privies, trash piles, and other features.

METHODOLOGY

The project included detailed historical research and archaeological fieldwork. Historical research took place before the fieldwork to develop a context for understanding the site and generate expectations regarding the archaeological remains. New South gathered available information about the history of the stamp mill and associated buildings. This task involved reviewing geological publications, information from the industrial census of the United States, first-hand accounts of the site, and technological information about the gold mining in the Carolinas. Research also covered changing industrial technologies used in gold mining. Finally, an effort was made toward finding references to the early mining operations, especially those related to the original stamp mill to determine if it was at 38LA383.

Fieldwork focused on identifying, mapping, and recording industrial and architectural features. Excavation focused on what was necessary to expose and interpret features and included clearing vegetation around the visible features to determine its layout and allow detailed mapping. Mapping was accomplished with a total station. In addition, all features were photographed, and selected features were hand-drawn to scale. (Features excluded from hand drawing were those considered to be modern or secondary rubble deposits).

The fieldwork also included excavation of two trenches to identify interior wall supports or other features. Trench locations were chosen based on the examination of the aboveground features. The trenches were placed on project maps and at least one profile was mapped and photographed.

Artifact recovery involved hand collection of specimens with chronological or functional associations, such as ceramics. Artifacts were brought to New South's laboratory in Stone Mountain, Georgia, where they were to be washed, analyzed, and stabilized. They were placed into functional categories (e.g., Kitchen, Architecture, etc.) that were used to organize discussions of the artifacts. Larger items, such as heavy machine parts, were not brought back for analysis but were photographed and described in the field.

Artifacts, notes, and other materials generated by this data recovery were treated in accordance with the *South Carolina Standards and Guidelines for Archaeological Investigations*. New South prepared the artifacts and records for permanent storage following the standards and guidelines of the South Carolina Institute of Archaeology and Anthropology.

REPORT ORGANIZATION

This report describes the results of the historical and archaeological study of the Haile Gold Mine stamp mill (Site 38LA383). The report provides an overview of the mine's history, the role of the stamp mill in the overall operation of the mine, and gold mining in general. Also included is a detailed description of the archaeological remains of the stamp mill recorded for this project.

The remainder of this report is organized as follows: Chapter II provides the geological context of Haile Gold Mine, which is important in understanding the way the mine was developed and how it changed over time. Chapter III describes the history of Haile Gold Mine. Chapter IV presents an overview of gold mining methods and technology used in South Carolina during the nineteenth to early twentieth centuries. Chapter V describes the field results and analysis of the site, and Chapter VI provides conclusions. Appendix A contains the artifact catalog.

II. PROJECT LOCATION, PHYSICAL SETTING, AND GEOLOGY

Site 38LA383 represents a portion of the historic extent of Haile Gold Mine. The site is located in Flat Creek Township in southern Lancaster County, about 3.5 miles northeast of the Town of Kershaw and lies just north County Road 188 (Haile Gold Mine Road) on the east side of Haile Gold Mine (formerly Ledbetter) Creek. The broader historic mine operation, which contained five open cuts and associated shafts, processing plants, workshops, housing, and other company facilities occupied both sides of the creek (Sloan 1908:66). Twentieth-century mining operations obliterated most of the historic mine-related features, leaving Site 38LA383 as the only remnant of nineteenth- to early twentieth-century mining activities (Figure 2).

Haile Gold Mine lies within the Sandhills geophysical province of South Carolina. This region forms a rough boundary between the Piedmont and Coastal Plain and overlies portions of each. Rounded hills and gentle relief characterize the region, which originated as an ancient shoreline during a higher stand of the Atlantic Ocean. Rivers carried sand and clay eroding from the mountains to the coast, where the ocean reworked them into beaches and dunes. Recession of the ocean about 40 million years ago left these shoreline features inland (Kovacik and Winberry 1989:18). Soils are typically permeable, well drained, acidic, and deficient in plant nutrients. White sand to red-brown lateritic soils are typical (Kovacik and Winberry 1989:41; Diemer and Bobyarchick 2005; Hulse et al. 2008:15). Elevations at the Haile Gold Mine Property range from 122-168 meters (400-550 ft.) above sea level (Hulse et al. 2008:16). Site 38LA383 lies at elevations between 122 and 137 meters (400-450 ft.).

GEOLOGY OF GOLD IN THE CAROLINAS

In the Carolina Piedmont, gold-bearing mineral deposits are mostly stratabound in metavolcanic-metasedimentary sequences or associated with intrusive bodies. Volcanic-hosted massive sulfide deposits are an important source of base metals, silver, and gold. In general, these occur in the Carolina slate belt. The most important gold-bearing sulfide deposits of the Piedmont were those of the Cid District in Davidson County, North Carolina, the Gold Hill District in Rowan, Stanly, and Cabarrus counties, North Carolina, and the Lincolnton-McCormick District, McCormick County, South Carolina. Host rocks for these massive sulfides include metamorphosed felsic pyroclastic rocks including the Uwharrie Formation and Albemarle Group in North Carolina and the Persimmon Fork Formation, Richtex Formation and Lincolnton metadacite in South Carolina. Gold was also situated in stratabound stratiform massive sulfide deposits and volcanic-hosted and carbonate-hosted deposits in the Piedmont. The greatest part of this mineralization is the Carolina Slate Belt metavolcanic rocks, with minor amounts from the Kings Mountain Belt (Feiss et al. 1991:328-329).

Figure 2.
Aerial Showing Twentieth-Century Mining of Haile Gold Mine, which Significantly Impacted the Historic Mine Properties

Source: Google Earth 2011

The Carolina Slate Belt comprises a rock unit extending from Georgia to Virginia and consisting of volcanic and sedimentary rocks subjected to greenschist facies metamorphism about 550 million years ago (Romarco Mineral, Inc. 2008). This unit, which accounted for most gold production in the Carolinas, contains thick sequences of undifferentiated felsic and mafic metavolcanic rocks.

Two stratigraphic divisions of the Carolina Slate belt are relevant to Haile Gold Mine: the Persimmon Fork Formation and the overlying Richtex Formation. The Persimmon Fork Formation is mainly composed of felsic to indeterminate crystal-lapilli tuff possibly deposited as a series of ash flows. This rock unit also contains several other types of metavolcanic and metasedimentary rock as stratiform lenticular sheets. It contains variable amounts of quartz, albite, white mica, chlorite, biotite, and carbonate (Butler and Secor 1991:72; Foley et al. 2001:892; Romarco Mineral, Inc. 2008). Above these volcanic formations lie thin bedded to massive mudstone and wacke interlayered with mafic tuffs and flows, and intruded by sheets and plugs of epizonal mafic igneous rock (Butler and Secor 1991:72; Feiss et al. 1991:332; Maher et al. 1991:99; Foley et al. 2001:893). The Richtex Formation includes quartz, white mica, chlorite, biotite, and carbonates (Romarco 2008).

Stratabound gold mineralization was common at the transition site from the metavolcanic to the metasedimentary sequence, and most Carolina Slate Belt gold mines and prospects lie along or within a mile of these contacts (Feiss et al. 1991:332; Murphy 1995:83; Carpenter 1999:18). Gold typically occurs as submicroscopic particles disseminated in unaltered metavolcanic and metasedimentary rocks. Where present, gold is always associated with pyrite, but there are extensive areas of barren pyritic rocks. In quartz, gold occurs as individual grains and ribbons. In pyrite, it occurs as inclusions, and in quartz and pyrite, it occurs on grain boundaries and fractures (Feiss et al. 1991:332).

Thick saprolite has developed on and into the bedrock and is overlain by Coastal Plain sediments (Hulse et al. 2008:20). Gold mineralization is within the Richtex Formation at or near the contact with the Persimmon Fork Formation. Gold bearing zones are associated with silicification and some pyrite mineralization (Romarco Mining Inc. 2008). Based on an analysis of the deposits, the ore at the site was characterized as free milling and the gold recoverable by direct cyanidation after grinding (Hulse et al. 2008:76).

GENESIS AND DISTRIBUTION OF GOLD

Gold-bearing quartz veins and disseminated lode deposits formed through ancient volcanic activity and the effects of hot circulating water. Disseminated deposits formed at the same time as the associated rocks and commonly occur with iron and copper sulfides (pyritic materials). Gold-bearing quartz veins formed later when mountain building caused the original rocks to heat, deform, and fracture (Knapp and Glass 1999:6). As magma cooled and created granite plutons, elements within it bonded and crystallized in an orderly way determined by each mineral's crystallization temperature, the presence of other minerals, and the temperature of the cooling magma. Quartz and rare metals such as gold, silver, copper, and platinum crystallized last and, as hot liquid solution, filled cracks in the granite and spread into the nearby surrounding rock. When the gold finally solidified, it formed concentrated pockets or flakes within and near the quartz veins (Murphy 1995:81-82).

Gold occurs widely but sparsely through the earth's crust and waters and only a small portion of it became massed enough to be economically recoverable (Butterman and Amey 2005:12, 14). Gold so aggregated exists in two principal forms: placers and lodes, with lodes being subdivided into veins and mineralized zones or replacement deposits (McCauley and Butler 1966:14-15; Carpenter 1999:16). Lodes are primary deposits containing the gold as it first concentrated while placers are secondary deposits containing gold eroded from lodes. Lode deposits occur in diverse shapes and sizes including tabular crosscutting vein deposits, breccia zones, irregular replacement bodies, pipes, stockworks, and other shapes. Replacement deposits are mineralized zones of country rock. Ore in this form is usually fine-grained, hard siliceous rock with disseminated pyrite (McCauley and Butler 1966:15).

Replacement deposits, gold is associated with volcanic country rock that was altered and mineralized, chiefly to quartz, sericite, and chlorite. Mineralized zones may be greater than 30 meters (100 ft.) wide and have indefinite boundaries that grade into the country rock. Ore quality varies throughout and gold typically occurs in only a small portion of the zone. Gold in disseminated deposits is so finely distributed that it is difficult to detect without magnification or other means. Gold is often hosted within the sulfide minerals, particularly pyrite (Carpenter 1999:16-18). Typically, the mineralized zones contain low-grade gold ores that must be extracted through complex mechanical and chemical procedures to make their recovery worthwhile.

Veins are tabular, sheet-like, or lenticular bodies mainly composed of quartz with varying amounts of other minerals. They are typically narrow, less than four feet wide, although might reach as much as 40 feet, and may extend for hundreds of feet. They may also vary in size along their horizontal and vertical dimensions, and they may be isolated or occur in parallel groups. They normally have sharp contacts with the country rock (McCauley and Butler 1966:15; Carpenter 1999:16). In South Carolina, most lode mines were developed on quartz-pyrite veins. However, the most productive mines, Haile Mine included, derived ore from replacement deposits (McCauley and Butler 1966:15).

Placers are secondary deposits containing gold derived from weathered and eroded lodes that have been transported and concentrated by gravitational forces, water, and wind. They are found mainly on present stream valleys flowing through the areas where lode deposits occur but can also be found in relict streambeds floating in valley or ridge slopes. Some placers are also in colluvial material that moves downslope but has not been influenced by stream action. In the Piedmont, placers can also lie in residual saprolite overlying weathered lode deposits (McCauley and Butler 1966:14; Murphy 1995:82; Carpenter 1999:19; Butterman and Amey 2005:14). In South Carolina, placers usually occurred close to their source lodes (McCauley and Butler 1966:14).

Alluvial deposits containing gold are usually three to six feet thick but vary in width and thickness depending on the material available for transport, the size and velocity of the stream, and the terrain the stream crosses. These deposits overlie weathered but undisturbed country rock. The coarsest fragments of alluvium, usually quartz, settle immediately above the country rock and deposits grade up to finer material. Gold typically occurs with the coarse layer (McCauley and Butler 1966:14; Carpenter 1999:19). In placer deposits, gold is loose or free and can be collected through relatively simple methods such as hand picking. Most often, placers were worked with simple mechanical methods such as panning, rockers, sluices that are discussed in detail in Chapter IV.

At Haile Gold Mine, gold occurred as both lode and placer deposits. Although placers were apparently mined early in Haile's history, the lode deposits were quickly discovered along hillsides and these were mined extensively during the antebellum period. The most productive lodes at Haile were zones where fine-grained quartz and pyrite mostly replaced the schist. The gold-bearing lodes were within two zones about 1,500 feet apart and that trended northeast parallel to the prevailing rock structures. Each zone was 100 to 200 feet wide and 1,800 feet long. Separate ore bodies within the zones ranged from stringers to masses several hundred feet long and deep, and 100 feet or more wide (Pardee and Park 1948:112-114). The ore bodies were lenticular in shape and oriented northeast to southwest like the structure of the prevailing rock structure. They were worked historically with both underground mines and large open cuts (Nitze and Wilkens 1896:767; Graton 1906:83).

III. HAILE GOLD MINE HISTORY

To help address historical issues, New South established the chain of title for the land Haile Gold Mine occupies (Table 1). Additional primary and secondary sources provided information about the history of gold mining at Haile as well as important developments in its history and its operation. This information offered important contexts for understanding the archaeological materials at 38LA383 and addressing the research questions for the project. The details of the site's ownership history and other information are presented in the text below.

HISTORY BEFORE 1827

Euro-American settlers first entered north central South Carolina in the early 1750s. Most were Scots-Irish, and many reportedly came from Lancaster County in Pennsylvania. Other settlers, both Scots-Irish and English, came from the more settled portions of South Carolina and Virginia. Catawba Indians and a smaller Native group called the Waxhaws already occupied the area (Floyd 1968:1). The local Indians were quickly marginalized as the first settlers set up roads and plantations similar to what was already established along the coast. Settlement soon followed along Lynches Creek, Little Lynches Creek, and Flat Creek, an area that encompasses southeast Lancaster County. Land grants in this area continued until several years after the American Revolution. The Camden-Waxhaw Road, which later became part of the larger Charleston-Salisbury Road, was in place by the 1760s (Floyd 1968:3). U.S. Route 521 running through Kershaw is a portion of this historic road between Camden and Lancaster. U.S. Route 601, approaching from the northeast, joins Route 521 in Kershaw.

The original land grant containing what is now Haile Gold Mine is not known for certain, but it could be the 2,014-acre tract John Marshal (Marshall) received from Thomas Pickney, governor of South Carolina, on March 6, 1787. Marshal sold this tract to William Welsh on December 27, 1792, for 54 pounds. The deed stated that the 2,014 acres were located on Little Lynches Creek, bounded to the southeast by lands of John Marshal and William Welsh, to the southwest by lands of Samuel Mathis(?) and vacant lands, and to the north and northeast by vacant lands and those of Kimbell(?), Benjamin Darnel, William Welsh, and Gray (Lancaster County Deed Book F:178).

Welsh had extensive landholdings in the area. The first time that the Haile area can be definitely placed within a known tract is on the occasion of a transaction between Welsh's son, Thomas, and Benjamin Haile on March 9, 1818 (Lancaster County Deed Book I:80). The preface to the deed stated that the land had been conveyed to Abraham Horton and William Horton, Senior, to be held in trust for Thomas Welsh, presumably until he came of age. In 1817, the land was surveyed according to a writ of partition of the estate of William Welsh from the Court of Equity of Camden District. S. H. Boykin and L. Young performed this survey, recording it on a plat dated March 6, 1817. This plat, covering 3,664.6 acres, showed land on both sides of Little Lynches Creek (Boykin and Young 1817; Lancaster County Deed Book I:78-79).

Table 1. Haile Gold Mine Chain of Title

Date	Grantor	Grantee	Land, Price	Lancaster County Deed Book:Page
*1787 Mar 6**	*Thomas Pickney, State of South Carolina*	*John Marshal*	*2,014 ac., original land grant*	*Mentioned in F:178*
1792 Dec 27	*John Marshal*	*William Welsh*	*2,014 ac., 54 pounds*	*F:178*
1818 Mar 9	Thomas Welsh, son of William Welsh	Benjamin Haile	3,664.6 ac., $5,500	I:80 (plat in I:77-78)
Benjamin Haile II died June 26, 1849 (his father died 1842, probably in Virginia).				
Haile's Gold Mine Tract, 1,805 ac., platted by S. H. Boykin at request of Edward Haile, administrator of estate, 1850 (Plat in S:328). In 1853, family agreed to sell land for $20,000 (S:326).				
1862 Oct 22	William R. Taylor, Kershaw District Clerk of Equity	Anderson A. N. M. Taylor	1,805 ac. ("Haile Gold Mining property")	S:326
Sherman's troops destroy mine facilities, late February 1865.				
1866 May 1	Anderson Taylor and Daniel Asbury (Taylor & Asbury)	Phineas B. Tompkins, of New York	Undivided ½ interest in 1,805-ac. tract, $10,000; property to be restored for mining.	S:501
1868 Dec 15	Taylor and wife	Phin. B. Tompkins	Remaining interest in 1,805-ac., $75,000	U:95
1880 Aug 2, public sale (deed Nov 3, 1880)	Court of Common Pleas	Frank W. Eldridge, highest bidder	$8,800	C-2:63
1880 Nov 12	Frank W. Eldridge	Haile Gold Mining Company	1,805 ac., $100,000	C-2:65
Haile Gold Mining Company: management under E. Gybbon Spilsbury, 1880-88; management under Adolph Thies and family, 1888-1908. Zenith of historical operation at Haile Gold Mine in the years before stamp mill explosion on August 10, 1908.				
1911 June 20, public sale	Circuit Court of Common Pleas (L. W. Ammerman and Charles D. Jones, receivers of Haile Gold Mining Co.)	John T. Stevens (president of Haile Gold Mining Corp.)	1,805 ac., $69,000	S-2:555
Leases: A. K. Blakeney for pyrites for sulfuric acid, 1915-17; Kershaw Mining Company, 1917-18 (failed after World War I); in 1934, Haile Gold Mines, Inc. got property under lease-purchase contract from Haile Gold Mining Corp., 1934-42 (Bradt and Newton 1940).				
1946 June 21	Haile Gold Mining Corp.	James P. Beckwith	1,805 ac., $165,000	T-3:399
1946 June 21	James P. Beckwith	Haile Mines, Inc.	287.93 ac., $1	T-3:412; (plat in Plat Book 18:59)
Lease: Mineral Mining Corp, 1947 (Z-3:493); Timber sale: W. B. Smith, 1956 (M-4:320).				
1963 Aug 16	Howe Sound Company (formerly Haile Mines, Inc.)	Mineral Mining Corp.	287.93 ac. tract and other tracts, $40,000	F-5:334

Table 1. Haile Gold Mine Chain of Title

Date	Grantor	Grantee	Land, Price	Lancaster County Deed Book:Page
1990 Apr 30	Mineral Mining Corp. (later MMC Holding Inc.)	Mineral Mining Company, Inc. (a wholly owned subsidiary of Piedmont Mining Company, Inc.)	287.93 ac. tract and other tracts, for "full value"	C-9:142
1992 May	Piedmont Mining Company, Inc entered into a Joint Venture with Amax Gold Inc. Piedmont used MMC as its participating company (37.5% interest) with AGI creating Lancaster Mining Company (62.5% interest). Amax created Haile Mining Company, Inc. to manage the site and the project.			
1992 Oct 6	PMC changed Mineral Mining Company, Incchanged name to Kershaw Gold Company, Inc.			B-11:218; 457:34
1992 Dec 30	Kershaw Gold Company, Inc.	Joint ventured with Lancaster Mining Company, Inc. Haile Mining Company, Inc. created to manage the site		B-11:218; 229:105; 457:34
1992 Dec 31	Lancaster Mining Company, Inc.	Created Haile Mining Company, Inc. to manage the site for the venture.		229:102; 457:34
1997		Haile Mining Company purchased Kershaw Gold Company and owned 100% of property		
2007 Oct 15	Haile Mining Company, Inc.	Haile Gold Mine, Inc., subsidiary of Romarco Minerals, Inc.	287.93 ac. tract (Tract 1) & other lands, $5 and considerations	428:234

*Entries in italics represent the best possibility for the earliest portion of the chain for land now occupied by Haile Gold Mine. The 1818 transaction is the first that can definitely be tied to the Hail Gold Mine property.

This land was divided into three separate parcels. Benjamin Haile II bought Tract B, containing 3,561 acres east of the creek, for $5,500. The area that was later developed into the gold mine was near the center of this parcel. Haile purchased this land in 1818, but he had already acquired many other tracts in the late 1700s and early 1800s and he received a state grant for 625 acres on Little Lynches Creek as late as 1809 (State Grant Book Volume 42, page 185).

Benjamin Haile II was a prominent landowner and planter originally from Virginia (Pittman 2008:1-2). His father, Benjamin Haile I, was also a Virginia landowner and planter. Haile I appears to have been a colonel in the American Revolution, and as a result, was awarded lands in South

Carolina after the war. This is how both Hailes eventually came to South Carolina (Jack Morris, email to Ramona Schneider, Sept. 23, 2011). Because of this, many sources have confused the two men, especially since Benjamin Haile II is never identified as such in any of his deeds or wills. As a result, the birth and death dates of the two have been mixed up in many of the sources.

Benjamin Haile, Senior, was born near Fredericksburg, Virginia in 1745 and was married to Catherine Furgerson. Benjamin Haile II was born January 10, 1768 in Essex County, Virginia, and moved to Lynches Creek as a young man. Benjamin Senior died in 1842. Benjamin II died June 26, 1849 and was buried in Camden, South Carolina. At the time of his death, he reportedly owned over 11,000 acres and 206 slaves.

Benjamin Haile II married twice. His first wife was Mary Cureton, who bore him seven children. After Mary's death, he married again at age 43. His second wife was Amelia Evans, born June 15, 1795 on Lynches Creek in what is now Chesterfield County. She was 16 when they married on August 22, 1811. They also had a number of children. For much of their life together, they lived on Broad Street in Camden (Croxton 1948:1-3; Haile 1970; Boykin c. 1970).

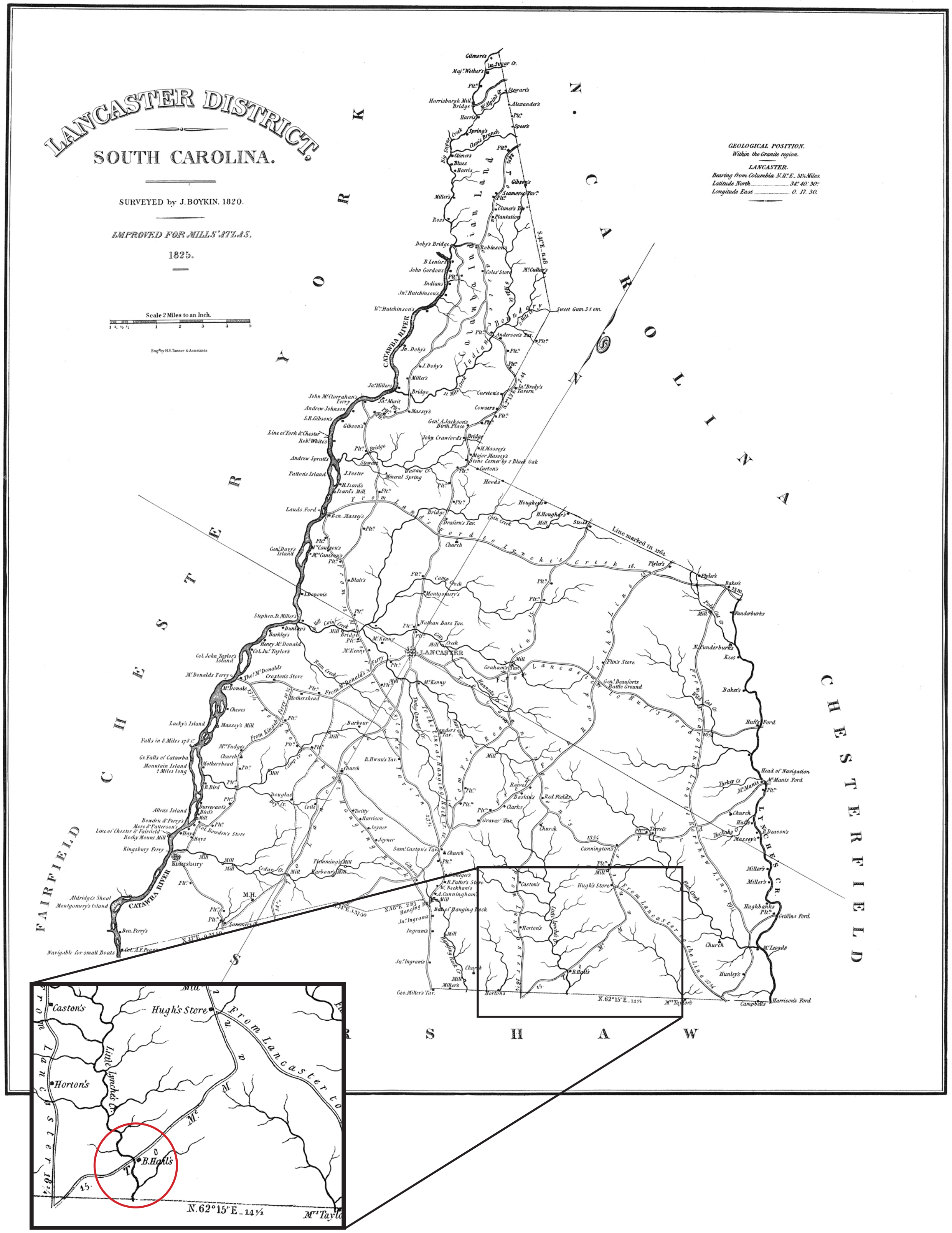
As early as 1800, Benjamin Haile was in Kershaw County with a household of three free white males, two free white females, and 14 slaves (Kershaw County Historical Society 2002:13). In 1820, his residence appeared on the Mills Atlas Lancaster District map as "B. Haile" on the east side of present U.S. Route 601 (Figure 3) (Mills 1980). By this time he owned a number of slaves (Lancaster County Deed Book I:69).

EARLY GOLD MINING DEVELOPMENT, 1827-1837

There are two accounts of the first gold strike on the Haile property. One was that Haile found gold while searching the local stream for clay to chink a log plantation building (Lindsay Pettus, personal communication, 2010). Another source stated that he found gold in 1827 in Ledbetter Creek, near the gristmill on his plantation (Hartley 2004). Louis Blanding, a former resident of Sumter County provided a more elaborate account, quoted in the *Lancaster News* (May 26, 1993):

> Some years before the Confederate war there came to Camden two northerners who hung around a considerable time, finally approaching a Mr. Haile, who was a large land owner of the county requesting him to sell them a part of his land, stating that they wished to become planters. Mr. Haile refused to sell but told them they were welcome to plant what land they wished if they cared to do so. Subsequently Mr. Haile found out that they had sunk a shaft and were mining for gold with some measure of success. He then ordered them to stop operations and demanded the return of the property. This they refused. Then ensued a lawsuit to compel them to surrender the property, which suit Mr. Haile won, and came into possession of the mine, which was worked until hostilities stopped operations. The Confederate government worked it for a time during the war for the sulphur contained in the ore to make gunpowder…. I know this, because my brother, William Blanding, was legal counsel for Mr. Haile in the recovery of the mine (newspaper article repeated in email from Louise Pettus to Lindsay Pettus, September 10, 2002).

Figure 3.
Mills Atlas of South Carolina, 1820, Lancaster District,
Showing Residence of Benjamin Haile



For the first few years, the extraction of gold was mostly limited to placer mining in Ledbetter Creek. Presumably, this was done by Haile or his assistants. Soon free gold was discovered in the schist beds on both sides of the stream. To exploit this resource, Haile divided the area into a grid of 50-foot squares and leased each one to local planters who put slaves to work mining the squares after seasonal agricultural work was completed. The gold ore was then hauled to "arrastras," Chilean mills, or "long toms" on neighboring creeks (Sloan 1908:59; Thies and Phillips 1892:66).

As the 50-foot squares went deeper, the collective excavations created large open pits. Most of the Haile pits that would later be famous started with these 50-foot units. After being hauled to the surface, slaves took the ore for crushing to arrastras located up to three miles away. Most of the gold recovered from the crushing process was free gold, but at least one source claims that at some was recovered through the amalgamation process wherein it was bonded with mercury to separate it from the waste rock (Lakes 1900a:56). Almost all the gold found in these early excavations was free gold found above the water table, estimated to have then been at less than 60 feet below surface. Below that level, gold was embedded in sulfides and difficult to extract through the methods available (Graton 1906:77, 82).

Just a few years after the mine's discovery, the *Richmond Enquirer* (1831) stated that Haile "has already taken from it about $10,000, and the ingots which we have looked at today amount to something more than $5,000, the produce of only two months. Captain Haile only works upon the surface, and that too upon a small scale." The following year, another article mentioned that "Haile's gold mine, situated on Little Lynch's Creek, and partly in this [Kershaw District] and Lancaster District, promises to be one of the richest mines in the Southern states" (Lockwood 1832:55). Haile mined some of the gold himself, sending a shipment to the U.S. mint in Charlotte. As for the 50-foot lots, the richest are believed to have yielded between $300 and $500, with surface mining only going to the depth of 25 feet below surface (Pettus 2011). State Geologist Michael Tuomey visited Haile Gold Mine during the mid 1840s and described it as being worked with open pits. By this time, the mine already exhibited several abandoned works characterized by waste piles of iron sulfides removed from the workings (Tuomey 1848:96).

Twenty years after the Civil War, E. Gybbon Spilsbury, who served as manager of Haile Gold Mine from 1880 to 1888, wrote a paper detailing the development of gold mining (published in 1884). Not speaking specifically of the operation at Haile, but of antebellum gold mining in general, he was blunt about its shortcomings. The work done by slaves and their white overseers was desultory and small in scale, with excavation rarely progressing below the water table. No one worked it as a job or approached it scientifically. As Spilsbury lamented, it was this lackluster work ethic, inculcated at all levels, which impeded industrial progress in the South, and certainly the local mining industry (Spilsbury 1884:99-100).

THE FIVE-STAMP MILL, 1837

Remarkably, little is known about the five-stamp mill that Haile set up on his property in 1837. The identity of the person who set up the mill is also uncertain, but some sources refer to a Frenchman named "Cugnat" or "Gugnot" (McLaughlin and Todman 2004:60; Gaither 1977). Most sources simply state that Haile constructed a five-stamp mill on his property (Nitze and Wilkens 1897:126;

Lakes 1900a:56). It was later claimed that this was only the second stamp mill to be erected in the entire United States (Gaither 1977; Hartley 2004; Pittman 2008:1-2). Presumably, this was the operation that was "irregularly worked by professional miners with varying success" before the Civil War (Sloan 1908:59). Despite the limited information, it is clear that the Haile operation, including the earlier work by planters and their slaves, along with the five-stamp mill, probably represented the zenith of gold mining in the Carolinas before the 1849 California Gold Rush.

BENJAMIN HAILE II AND HIS WILLS, 1836 & 1845

Gold mining made it possible for Haile II to live at the peak of South Carolina society. He served in the South Carolina legislature, and was on the Board of Trustees of South Carolina College, now the University of South Carolina (Pettus 2011). Many sources state that Benjamin Haile II died in 1842, but this was his father's date of death; Haile II died on June 26, 1849 and was buried in Camden. By this time, the California Gold Rush was in full swing, which deflated the southern gold industry, including operations at the Haile Gold Mine.

Haile II left two separate wills. The first was dated 1836 and the second 1845. Both mention the gold mine. In the first will, Haile detailed the property that was to go to his wife, Amelia, including the 559-acre plantation and the house in Camden, for the term of her life. His son Edward received the 3,664 acres on both sides of Little Lynches Creek that he purchased from Thomas Welsh, except for some smaller parts on the peripheries that went to others. The mines, however, received special consideration. The will's eighteenth clause stated that the mines would not go to Edward:

> I will and direct that the said mine or mines shall be kept working by my executrix and executors, in the same manner, and with the privileges to the miners or persons working, according to the rules and regulations prescribed by me as now exists, and with a force equally to what is now at work there for me individually, for the full period of ten years from the time of my death. And out of the profits of said working of said mines for the said ten years, I will and direct that the money Legacies hereinbefore bequeath to my children, shall be paid (Haile 1836).

After the legacies were funded, any profits from the mine would go to his sons Columbus, Thomas, Edward, William, John, and Charles Evans until each received $4,000. Only then was a similar amount to be paid to his daughters Caroline, Rebecca, and Elizabeth. None of the money was to be dispersed until the children reached the age of 21 or were married, whichever came first.

After the expiration of the 10-year period, the mine was to be left to his sons jointly, including any new mines that might be found on Edward's land. Additionally, "all the machinery and mills and mill seats now used by me in working said mine and mines, to be equally divided between them, share and share alike, to them, their heirs, and assigns forever, in fee simple." This clause referred to mining performed "either by myself, or the miners now working there for other persons on toll, and the right of road over said land, to said mines" (Haile 1836).

About nine years later, when the children were older, Haile prepared another will, dated to May 6, 1845. Amelia received the Camden house and other lands, including most of the slaves. Haile had many children and many tracts of land, but the disposition of the gold mine was one of the central features of the second will (Camden Chronicle 1927; Haile 1845). The gold mines went to sons William and Edward jointly, even though the land itself was given to William:

> I give and bequeath to sons William and Edward jointly the gold mines situated on Lancaster District on the Welsh tract…together with all the mills and appurtenances thereto belonging, to use the same in common with an equal right of way, water and timber too, and to divide equally the profits to arise therefrom, notwithstanding the lands on which they are situated, and have in another clause been given to William generally (Haile 1845).

THE 1850 PLAT

This joint arrangement did not work out, especially after the earlier will was brought forth in 1850. This resulted in a partition of some of the Haile lands, in particular the former Welsh tract, and a plat of the property, requested by Edward Haile, which was the first map to show the Haile gold mining operation (Figure 4).

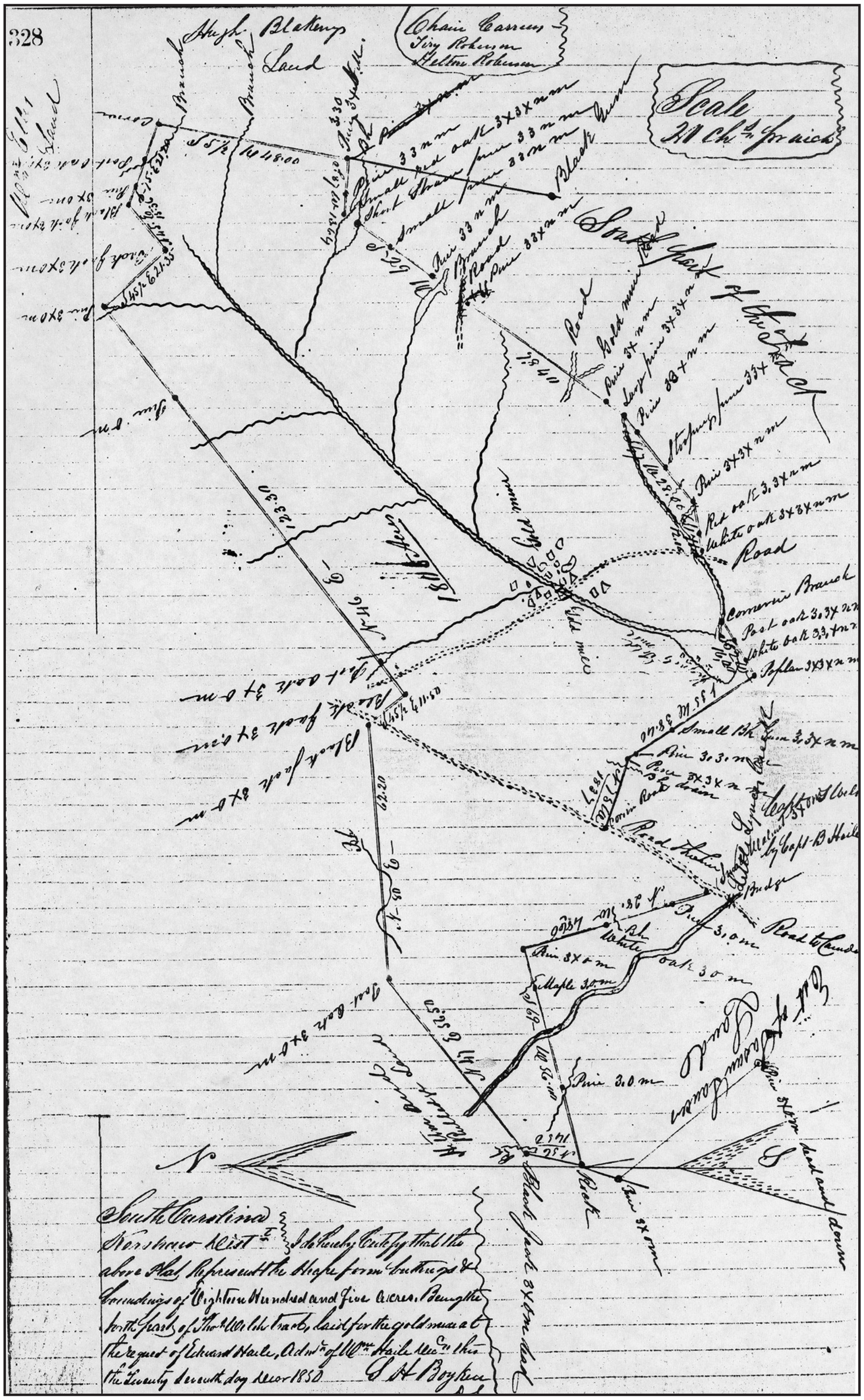
The 1,805-acre Haile Gold Mine Tract represented the northern part of the former Thomas Welsh property. The plat showed Little Lynches Creek at the western edge of this tract. The "road to Camden" (current U.S. Route 601) ran through the center of the tract and Ledbetter Creek was to the east. Where an unnamed road crossed that stream, there were a number of small irregular shapes labeled "gold mine," that probably represent the 50-foot plots leased out to neighboring planters. On the opposite side of the unnamed road was the label "gold mill." Further downstream, where it emptied into a pond, there was apparently another gold mill labeled "Kagnot's gold mill." This was presumably the five-stamp mill set up by the Frenchman "Cugnat" or "Gugnot" in 1837. If that is the case, then the 1837 five-stamp mill was in a different location from the main area of the mine, since it is almost certain that the excavation of the 50-foot plots led to the creation of what would eventually become the massive pits Beguelin and Haile pits. The remains of the 1837 mill, if they still exist, would be located downstream and on the opposite side of the creek from the nineteenth-century stamp mill (Site 38LA383).

THE 1850S

From all indications, the mining operation at Haile Gold Mine was successful, especially in the early days. Shortly after Benjamin Haile II's death, however, the California Gold Rush gutted mining operations across the South. Haile was also exhausting the limits of free gold found in the surface deposits. For both of these reasons, mining at Haile was virtually abandoned in the 1850s (McLaughlin and Todman 2004:60; Gaither 1977).

During this period, many members of the Haile family either moved west or to central Florida. At least three of Benjamin's sons relocated to the Gainesville, Florida area and invested in citrus orchards. Amelia Haile soon joined them and in 1880, she died in Arrendondo, Florida (Pettus and Bishop 1984:102; Boykin c. 1970).

Figure 4.
Plat of Haile Gold Mine Property, 1850



Source: Boykin 1850, Lancaster County Deed Book 5, (p. 328)

As early as 1853, the Haile family decided to sell the Welsh Tract with the gold mine, hoping to find someone willing to purchase the land for $20,000 (Lancaster Deed Book S:326). The family appears to have failed to find such a buyer, and when the property finally sold in the second year of the Civil War, the transaction was through the Kershaw District Clerk of Equity (Lancaster County Deed Book S:326).

By the end of the Antebellum period, the mine had essentially been shut down. Oscar Lieber visited the site in the 1850s as part of his survey of South Carolina, and reported that only a few people continued working the mine, being engaged in rewashing old tailings. At that time, the deepest work reached just over 90 feet and Lieber characterized the overall operation as rough and unsystematic as a result of "the injurious system of renting to small irresponsible companies [that] could induce no well regulated management" (Lieber 1858:62). Lieber's prognosis for the operation was positive, however, as he judged it to have a potential for significant deposits that would cause it to reopen in the future.

THE CIVIL WAR ERA, 1860-1866

On October 22, 1862, William R. Taylor, Kershaw District Clerk of Equity deeded over to Anderson A.N.M. Taylor the 1,805-acre tract identified as the "Haile Gold Mining Property" (Lancaster County Deed Book S:326). The price was not recorded.

Shortly after this transaction, if not before, Confederate authorities mined the property for ferrous sulfate, or "copperas," obtained from the local pyrite (McLaughlin and Todman 2004:60; Gaither 1977; Thies and Phillips 1892:76). One source said the Haile family leased the mine to the Taylor Brothers of Charlotte for $20,000 in Confederate money (Pettus 2011), one of whom was presumably the same Anderson A.N.M. Taylor mentioned in the 1862 transaction.

In one form or another, Taylor's operations at the mine continued until Sherman's march through South Carolina in the last year of the war. By late February 1865, the western-most wing of Sherman's army, Kilpatrick's cavalry and the 14th and 20th Corps, passed through the area. The 20th Corps in the vanguard, camped in the vicinity of the gold mine on February 28. They were also near "Clyburn's Store" (Davis et al. 2003: Plate 80.5). Sherman's men wrecked the mine before passing on towards Chesterfield and Fayetteville (Pettus 2011). One source stated that the Union troops canvassed the area looking for gold, seizing two men and demanding they reveal the location of any hidden treasure. When they failed to find anything, the soldiers destroyed the mine buildings and equipment (McLaughlin and Todman 2004:60).

After Sherman's troops left, the mine was inactive until May 1, 1866, when Anderson Taylor and Daniel Asbury, also known as Taylor and Asbury of Charlotte, sold an undivided half interest in the 1,805-acre tract to Phineas B. Tompkins of New York, for $10,000. One condition of the sale was that Tompkins was required to restore mining operations, "whereas circumstances have denuded the said property of all its buildings, mills, fixtures, and machinery necessary for the prosecution of such work" (Lancaster County Deed Book S:501).

PHINEAS TOMPKINS, 1866-1880

Two years after purchasing his half interest, Tompkins acquired the remaining half of the 1,805 acres from Anderson Taylor and his wife on December 15, 1868, for $75,000 (Lancaster County Deed Book U:95). The 1870 census documented Tompkins's operation as a gold mine with a capital investment of $50,000. Water provided the motive power at the mine and mill, estimated at 18 horsepower. This would not have allowed for a large operation, but it seems that Tompkins had a standard complement of equipment. The census return is difficult to read, but appears to list one trough, one tailings [pond?], one pump, six stamps, one amalgamation, one concentration, and one mill (hydro). He employed a total of nine men above the age of 16 and paid out $3,022 for the year. Also listed were mill supplies, including 30,000 feet of lumber. Production was 30 tons of talcose slate ($1,500) and 150 ounces of gold at $3,000 (U.S. Census 1870).

Tompkins's lasting contribution to the mine was the development of waterpower. The reservoirs depicted on later maps of the mine were probably first established by Tompkins. Years later, these impoundments provided all the water required for the mill and the chlorination facilities.

Despite the investments made by Tompkins, the mine proved unprofitable. It went up for public sale on August 2, 1880 and was awarded to Frank W. Eldridge for a bid of $8,800. The deed for this sale was dated November 3 of that year (Lancaster County Deed Book C-2:63). Just nine days later, Eldridge sold the 1,805-acre tract to Haile Gold Mining Company for the huge sum of $100,000 (Lancaster County Deed Book C-2:65).

Deeds indicate that Eldridge had only a brief involvement with Haile Gold Mine. However, local histories indicate otherwise. Many sources state that Eldridge bought the mine in 1866 and sold it in 1880 (Gaither 1977; McLaughlin and Todman 2004:60; Pettus 2011). This was almost surely a mistake, but with elements of truth. The Eldridge family was associated with the mine for a long time, but only briefly as direct owners.

According to a family history, Frank W. Eldridge, his father, Hobart Eldridge, and his uncle, James Eldridge, owned and operated mines in California, Virginia, and even Mexico before they became affiliated with Haile Gold Mine. It is possible that they managed Tompkins's operation between 1866 and 1880, or ran the mine during those years under a lease. The family history indicated Frank Eldridge bought Haile around 1880 and managed it in the years that followed. If he stayed on after immediately selling the property, he must have had close ties with the new owner, Haile Gold Mining Company. During this time, James Eldridge became owner of the Hobkirk Inn in Camden, operating it as a guesthouse for mine visitors and tourists (Eldridge 1953; Pettus 2011). Not all the details of these various stories can be squared into a credible narrative, but it seems likely that the Eldridges had a long association with the mine.

HAILE GOLD MINING COMPANY, 1880-1908

By 1880, the work at Haile Gold Mine had reached a crossroads. The near-surface deposits of free gold were mostly exhausted, and removing gold from the remaining sources was difficult. Excavations would have to go deeper, far below the water table, and the processing of the sulfide ore would be more complex. To proceed further would take considerably more capital than had been spent to this point and require chemical processes to extract gold from the host rock.

The Haile Gold Mining Company was prepared to tackle these problems. While under the control of this company, the mine reached what many consider its zenith, beginning in the 1880s and continuing on until the explosion of August 10, 1908. The mine's greatest managers operated during this period: E. Gybbon Spilsbury, Adolph Thies, and his son, Ernst (Ernest) Thies. Spilsbury was less successful than Adolph Thies and his son, but he laid the groundwork for the new mining operation and created much of the infrastructure that enabled the Thies family to succeed with their adaptation of the chlorination process.

E. GYBBON SPILSBURY, 1880-1888

Edmund Gybbon Spilsbury, the first general manager of the mine under the Haile Gold Mining Company, was born December 7, 1845 in London. He left England early and was educated at Liege and the University of Louvain in Belgium. In 1862, at the age of 17, he became an assistant engineer with the Eschweiler Company of Stolberg, Germany. After stints in Sardinia and Morocco, he returned to London for a while before taking a position with the Austro-Belgium Metallurgical Company. In 1870, he married Miss R. Hooper Smith of London and the same year Austro-Belgium sent him to the United States to inspect lead and zinc sources. In the U.S., Spilsbury became an independent mining engineer in New Jersey and Pennsylvania. In 1879, the Lynchburg Iron Company named him manager, and in 1881 took the same job at Haile Gold Mine, where he remained until 1888 (Cassier's Magazine 1898:95-96; Successful American 1903:106-107). Over his career, Spilsbury attained considerable wealth and professional prestige.

While at Haile Gold Mine, Spilsbury was ably served by a number of subordinates, foremost of whom was Robert Matthew Raymond, a native of New Brunswick, Canada. From 1882 to 1886, Raymond served as Spilsbury's assayer and assistant superintendent. Later he distinguished himself as a mining engineer, mine director, and educator (School of Mines Quarterly 1895:58; Engineering and Mining Journal 1920:365).

Spilsbury developed the first systematic mining procedures at Haile (Sloan 1908:59). He understood that it had become a low-grade mine, but believed it could be productive if the ore was processed efficiently. The largest and most promising deposits were in the Haile and Blauvelt pits. Spilsbury noted that the surrounding rock was generally a talcose slate, with crystals of iron and arsenical sulfides. The ore itself was more like quartzite than the host rock (Spilsbury 1884:101-102).

He also found that only one-third of the gold at Haile was in a free state that could be recovered through amalgamation. The balance was compounded with sulfur and required more elaborate treatment to release the gold. The average value of the ore was estimated at $11-12 per ton, from which only $3.50-4.00 of free gold could be obtained (Spilsbury 1884:102, 441-442).

While the nature of the ore made it difficult to turn a profit at Haile, there were additional problems with the work force. As an outsider to Southern culture, Spilsbury could see with crystal clarity the slapdash nature of the work that had been done with slaves and overseers. The glaring flaws of antebellum mining were still apparent in the operations he encountered in the 1880s. There was also the problem of what he called the "patent-process men," who virtually invaded the South, each with an exotic solution to the difficulties of getting gold from the local low-grade mines (Spilsbury 1884:100-101).

Spilsbury realized that solving the low-grade ore problem required improved power and improved infrastructure. To address those issues he made two big changes. Up to this point, all mining at Haile had been done in surface cuts (Lakes 1900a:5). Spilsbury switched to underground mining using steam-driven drills. These reportedly dropped the cost of extraction to 80 cents per ton, despite the greater depth. The ore was then hoisted out of the mine in rail cars and taken to the stamp mill (Spilsbury 1884:102).

The second change was at the stamp mill. The water-powered stamp Tompkins used was inadequate for the new arrangement. Spilsbury replaced it with a 20-stamp mill and installed a steam plant for power. Each stamp weighed 750 pounds and dropped seven inches 80 times per minute. The crushed ore then passed through a 40-to-an-inch mesh screen to amalgamation tables. In a day, the mill could process 35-37 tons of ore (Spilsbury 1884:102; 1885:441-442). Milling went on day and night, even on Sundays (Appendix to the Journals 1887:193).

Spilsbury also put new procedures into place to treat the ores. First, amalgamation recovered the gold freed in the stamp mill. Gold sulfide passed through amalgamation as tailings that went through a process of concentration to eliminate as much of the worthless gangue as possible. These concentrates then went to the "roasters" or furnaces for further treatment (Spilsbury 1884:102-103).

For Spilsbury, roasting, followed by additional amalgamation, was the key to dealing with gold sulfides, processes he described in two articles he wrote in 1884 and 1885. Roasting was done in a special mechanical furnace, comprised of a 450-foot long large coiled pipe made of wrought iron. The ore was blown through this coil heated to low red hot, causing the sulfides to be expelled and at the same time creating sufficient friction to free the gold from the rest of the sulfide and making it ready for final amalgamation. The *Kershaw Gazette* reported that one of the new pieces of equipment at Haile was a Manhattan Company Furnace used to roast sulfides. After experimenting with this device, one was finally constructed at the mine in 1883. The inventor of the furnace, Thomas Walker, supervised the work (Kershaw Gazette 1883). In the end, the "Walker furnace" did not perform as promised and had to be abandoned (Lakes 1900a:56). It is likely that this Walker furnace was the one with the large coil that Spilsbury (1884:103) described.

When this furnace failed to function properly, Spilsbury turned to the more reliable "fortschaufelung," essentially a compound reverberatory furnace. Considered old-fashioned compared to mechanical roasters and requiring labor-intensive "rabbling" (hand-stirring the heated ore), the expense of the fortschaufelung was offset by the low cost of Southern labor and fuel. After roasting in either furnace, the ore went to the amalgamation works (Spilsbury 1884:103; Thies and Phillips 1892:75). What could not be cracked through roasting and a final round of amalgamation was discharged into the stream (Lakes 1900a:56).

After roasting eliminated most of the sulfur from the ore, the ore went to the amalgamation works. Spilsbury first used "the old Freiburg barrel-process of amalgamation," which took too long to satisfy the needs of a commercial operation. To speed the process, he used a method developed by French mining engineer P. G. Designolle, who added a solution of bi-chloride of mercury to the ore, rather than metallic mercury (Spilsbury 1884:103-104).

The Designolle process worked best with roasted sulfides, although it was generally considered unsatisfactory. Spilsbury perfected a process that called for 600 pounds of roasted ore to go into the cast iron barrel with 1000 pounds of cast-iron balls. The barrel was then partly filled with water and a half-gallon of bi-chloride of mercury. The barrel was rotated briefly, after which another half gallon of the solution was added, followed by more rotation, which caused the gold to form an amalgamation with the bi-chloride of mercury. The mix was poured from the barrel into a large settler with mercury. This was followed by agitation, after which the gold was pulled out of the solution. The pulp then went to revolving centrifugal plates, which caught the bits of amalgam followed by yet another settler to catch more (Spilsbury 1884:104; 1885:442; Rose 1898:136).

Spilsbury summarized the cost of his operation in 1884 by stating that:

> With our plant, costing in all less than $4,000, including building, we can treat from 18 to 20 tons per day, with the labor of one man and one boy. The whole cost of treatment at our mill, including chemicals, labor, steam, and wear and tear on machinery, is 38 cents per ton (Spilsbury 1884:104).

In the end, Spilsbury recognized that he did not have great success processing sulfides at Haile (Spilsbury 1887:770-775). He summarized the different techniques used at the mine, beginning in 1880, when much of the mining was still possible above the water table. For a few years, the recovery of gold from the stamp mill and amalgamation was perfectly adequate. As the mines produced more and more gold sulfides, however, production at the stamp mill declined. Changing the original 30-40-mesh screen was an improvement, but did not remedy the problem. Spilsbury tried roasting the sulfides, followed by the Designolle process, which proved unsatisfactory and had to be abandoned. Next, the Plattner chlorination method was tried without success. Spilsbury contemplated sending a matting of the auriferous iron sulfides to large copper smelting companies for processing, but this was judged uneconomical. Finally, he considered the barrel chlorination process, which he believed might be the answer to the problems of the sulfides at Haile Gold Mine. Spilsbury became convinced that this was the key:

> Chlorination by this method can easily be accomplished at a total cost of less than $4 per ton, which would not be onerous on concentrates which yield over $25 per ton. I am now preparing the plans for the erection of a plant on this system having a capacity of 25 to 30 tons per day, and should the results in practice come up to my calculations, we shall be able to show a yield of 92 per cent on all ores treated. I hope on some future occasion to communicate… the results of these operations (Spilsbury 1887:775).

Spilsbury never implemented the barrel chlorination method at Haile. In early 1888, Adolph Thies replaced him as manager and introduced his version of the barrel chlorination system.

Spilsbury's tenure was marked by various experiments to try improving the gold yields at Haile. Another of his efforts involved the installation of a Blake dry crushing mill in 1885. This 200-ton mill was supposed to supplement the earlier 50-ton mill:

> The Blake Crusher Company of New Haven, Connecticut, has taken contract to erect and run a new 200-ton mill of the Haile Gold Mining Company, using its new crushers, revolving screen, and Krom steel rolls for the fine crushing; the maximum size to pass through a 60-mesh screen. Provision is made to dry in a Stetefeldt-Hasenclever shelf furnace if necessary (Engineering and Mining Journal 1885:91).

The Blake mill, equipped with 20 Embrey tables, could not process the ore efficiently and was soon abandoned in favor of the 20-stamp mill (Nitze and Wilkens 1897:126; Lakes 1900a:56). The stamp and Blake mills were located either in the same or adjacent buildings. Later, the Blake mill was stripped to make room for the 60-stamp mill built by the Thies family.

A development during Spilsbury's tenure was the establishment of a community associated with the mine. "Haile's Gold Mine" had a post office, established as early as 1879 (Pittman 2008:21), a village, a large store, and by 1884, a church. There was also a steam sawmill (Appendix to the Journals 1887:193). The mine also obtained a small-gauge railroad, probably installed by Spilsbury, to connect the mines with the new stamp mill (Cassier's Magazine 1898:96).

Spilsbury is a forgotten figure at Haile Gold Mine. Alluding to his management results years later, one source stated, "after an extensive assortment of experimental machinery was gradually accumulated, this effort resulted in financial loss" (Sloan 1908:59). Eclipsed by Adolph Thies, Spilsbury has been largely overlooked in local history. This is unfortunate, because he did much to make Haile a success by establishing much of the infrastructure that was later used and adapted by Thies. He also installed the Bleichert system of aerial tramways, which used the Elliot "locked" wire rope for hoisting (Cassier's Magazine 1898:95-96). He also kept the Haile operation alive at a time when mining was in decline throughout the Carolinas. In the 1880s, among only three or four active gold mines in South Carolina, Haile was always the most productive (Reports and Resolutions 1886; Appendix to the Journals 1887:193; State Department of Agriculture 1888:33). Moreover, Spilsbury recognized in the end that barrel chlorination was the most promising of the different techniques designed to deal with the sulfide ores.

Spilsbury's career did not end in the aftermath of Haile, nor did he terminate his association with the mine. After leaving Haile, he moved to New Jersey and spent the rest of his life in the New Jersey-New York area. He became director of the Trenton Iron Company in New Jersey, a post he held until 1897. In 1896, he was made president of the American Institute of Mining Engineers (Cassier's Magazine 1898:95-96). As late as 1903, he was still a director and consulting engineer for the Haile Gold Mining Company (Successful American 1903:106-107). He died on May 28, 1920 (American Society of Civil Engineers 1921:913).

DEVELOPMENT OF HAILE GOLD MINE UNDER CARL THIES (1888-1908)

Dr. Carl Adolph Thies arrived at Haile Gold Mine in January 1888 for the express purpose of profitably extracting gold from sulfides (Thies and Phillips 1892:67). Thies developed modifications to the chlorination process, which brought Haile Gold Mine considerable success and renown in the late 1800s and early 1900s.

Thies was born in Germany on July 1, 1832 and received his education there. His early work took him all over Germany and then South Africa. In 1860, on the eve of the American Civil War, he began working for the Union Consolidated Copper Company in Ducktown, Tennessee. In 1861, he returned to Germany to marry, and brought his wife to Ducktown. He remained there until 1862, when he took a position at a lead mine in Spartanburg County, South Carolina. Following the war, he worked on various gold projects in Dahlonega, Georgia, until 1873, after which he spend five years in Alabama. In 1878 he assumed a management position at the Phoenix Gold Mine near Concord, North Carolina. Here, Thies worked with the Mears chlorination process, which involved applying chlorine to the ore under pressure. During this time, he also became familiar with Haile and its problems with sulfide ores (Thies 2008).

Like Spilsbury, Thies saw Haile was a large quantity, low-grade gold mine that could be made profitable by solving sulfide problem (Lakes 1900a:56). Thies's solution was to introduce the barrel chlorination method, a process that he had tinkered with and improved upon since his days at the Phoenix Gold Mine (Thies and Phillips 1892:81; McLaughlin and Todman 2004:60-61). Thies did not invent the chlorination process, but he added his own elements, streamlining and economizing certain features. For the time, it was the best method of extracting gold from the sulfide ores that locked up two-thirds of all the gold at the Haile Mine. As one contemporary source stated, if you looked at the ore produced in the mine, you would never even know that Haile was a gold mine: "visible free gold in the coarse ore is rare" (Graton 1906:82).

BEGINNINGS, 1888-1902

Thies implemented additional changes to the mining process at Haile and expanded the infrastructure between 1888 and 1902. Changes included new mining equipment, adding a new mill, and upgrading the chlorination plant. Thies also continued the underground work begun by Spilsbury. Underground mining was conducted almost exclusively until around 1902, after which open-cut mining resumed, but on a larger scale than before (Graton 1906:77). Mining was performed with single and double-handed drills as well as machine drills, the latter including four Ingersoll-Sargeant drills with 3.5-inch cylinders (Thies and Phillips 1892:71). A diamond drill was used for exploration (Pittman 2008:23).

By 1890, Thies had installed a steam plant beside the Beguelin mineshaft with two boilers, providing 90 and 35 horsepower, each consuming six cords of pinewood every 24 hours at a cost of $1.40 per cord. The plant supplied power to various mining equipment including: a 20x30-inch Ingersoll air compressor, used to operate the hand and machine drills; one 40-horsepower Dickson reversible link motion-hoisting machine to haul materials out of the mine; one 20-horsepower engine for a 20x10-inch Blake crusher, necessary as a preliminary stage in ore dressing; and one pump, capable of removing water from the mine at a rate of 200 gallons per minute.

Processing the ore began at the edges of the mines themselves. After the ore was hoisted up in skips, it was discharged into two grizzlies before proceeding to the crusher. Each grizzly had a square surface of 32 feet, with bars set 1.5 feet apart. The so-called "shaft-smalls" would pass through while larger ores went to the 20x10-inch crusher. The grizzlies and crushers discharged into ore-bins at the edge of the pits, each with a capacity of 30 tons (Thies and Phillips 1892:71-72).

A narrow gauge railroad extending around the perimeter of the mine complex carried the ore from the bins to the next stage of the operation at the stamp mill. The total length of track was three-fourths of a mile. A trainload was considered seven cars, each car carrying three tons of ore. An engine driver and two assistants handled the train and the cars, and worked on the track as needed. The crew loaded the ore from the bins into the cars, took the ore to the stamp mill, and discharged it from the bottom of the cars into the mill bins on the top floor of the stamp mill. Here, the ore landed on an iron-plated comb that divided the material into east and west bins, which then fed the stamps (Thies and Phillips 1892:72).

When Thies arrived in January 1888, the mine still operated the 20-stamp mill that Spilsbury constructed. Thies immediately installed eight concentrators to handle mill tailings and a chlorination plant with roasting furnaces and a two-barrel chlorination facility that was later enlarged to three. After the chlorination facility proved successful, Thies enlarged the stamp mill to 60 stamps, positioned back-to-back with an accompanying 20 concentrators in 1889-1890 (Nitze and Wilkens 1897:126, 129; Lakes 1900a:56).

HEYDAY, 1892-1908

In the first two years under Thies's management, while he set up the chlorination process and expanded the mill, Haile processed 36,000 tons of ore (Thies and Phillips 1892:66). This figure greatly increased in the years that followed, after the facilities at Haile Gold Mine were complete and put into operation. Average production, which had been 25 tons a day under Spilsbury, increased five times to 125 tons per day (Gaither 1977). Using the Thies barrel chlorination process, Haile became what was commonly considered the most successful gold mine east of the Mississippi River. By 1908, the mine had a recorded output of 750,000 tons or ore, yielding between $2.60 and $10 per ton, with the average above $3.50 (Sloan 1908:59).

The mine reportedly produced one gold bar per month, each valued at $7,000 to $8,000 dollars. This was the best production record in South Carolina. According to other sources, total output per year ranged from between $70,000 and $150,000, and by 1908, when operations stopped, the total production was estimated to have been $3.5 million (State Department of Agriculture, Commerce and Immigration 1908:141; American Fertilizer 1922:34).

The era between the completion of the 60-stamp mill in 1892 and the boiler explosion on August 10, 1908, is the best-known period of Haile Gold Mine. The operation was famous throughout the mining world and was known as a primary example of the chlorination process. It was certainly the premier gold mine in the South. Mining engineers and many others visited Haile, and Thies freely offered advice on his chlorination process, which he did not patent. By the late 1890s, the barrel-chlorination process, in various forms, had become one of the most common around the world. Chlorination of gold was ultimately overshadowed and made obsolete by the cyanide process that is the most common extraction method in use today (Yeates et al. 1896:534; Wilson 1897:98; Gaither 1977). Even so, the chlorination method was highly successful in its day.

Given Haile's reputation, it is not surprising that the earliest maps and photographs of the mine date to this period. There are at least three maps from this time: one from 1896 (Figure 5); another dated 1906 that shows roughly the same arrangement as 1896; and one that shows the mine around World War I, when many of the structures from this period remained in place (Figure 6). All show the same main features.

THE MINES

By 1908, there were at least five open pits and one underground mine at Haile. The five open pits were named Haile (divided into Old Haile and New Haile), Bumalo, Beguelin (aka Blauvelt or Blue Pool), New Beguelin, and Flint. The underground works, known as the Cross Pit, extended below the Haile, Flint, and Bumalo pits (Sloan 1908:64-65; Graton 1906:78). Work moved from one pit to the other, depending on the availability of the ore and its chemical composition. Spilsbury began development of the underground Cross Pit, but this work ceased between 1888 and 1891 in order to concentrate on Beguelin for a few years (Lakes 1900a:56). The deepest workings at the mine, located in the Cross Pit, reached a depth of at least 475 feet below surface (Floyd 1968:89).

The enormous pits exposed large vertical diabase dikes. There were three main dikes at Haile Gold Mine, all roughly parallel and within 1,200 horizontal feet of each other. Far from being a problem, these hard rock features provided useful support for the mine as excavation proceeded downward (Sloan 1908:63-64).

The pits reached considerable depths. The Haile pit achieved a depth of 200 feet, while the Beguelin pit went to 180 feet. Shafts reaching several hundred feet extended the works (Sloan 1908:68, 70, 74). Underground mines below the 85-foot deep Bumalo Pit, for example, reached 480 feet below surface. One-inch steel hand drills and 1.125-inch machine drills were used, with air drills doing the heavy work. One of the Rand drills, known as the "Little Terror," had a diameter of 3.125 inches. Blasting was done with 40 percent Hercules powder and water in the pits was handled with a single No. 9 Cameron pump (Lakes 1900a:57).

The miners at Haile used the pillar system in underground workings of the Cross Pit. First, they dug a vertical shaft into the ground, and then horizontal "drifts" from the shaft at different levels. Chambers were then dug out from the drifts in such a way that the excavated material fell from an upper chamber to a chamber below where it was roughly sorted by grizzlies and caught by rail cars. Oversize rocks were broken up with sledgehammers. Pillars were left in place to support the chambers and no support timbers were used. The pillars were between 15 and 20 feet thick and supported chambers measuring 100x100 feet and 40 feet high (Lakes 1900a:57; Graton 1906:75-76).

Figure 5.
Map of the Haile Gold Mine, 1896

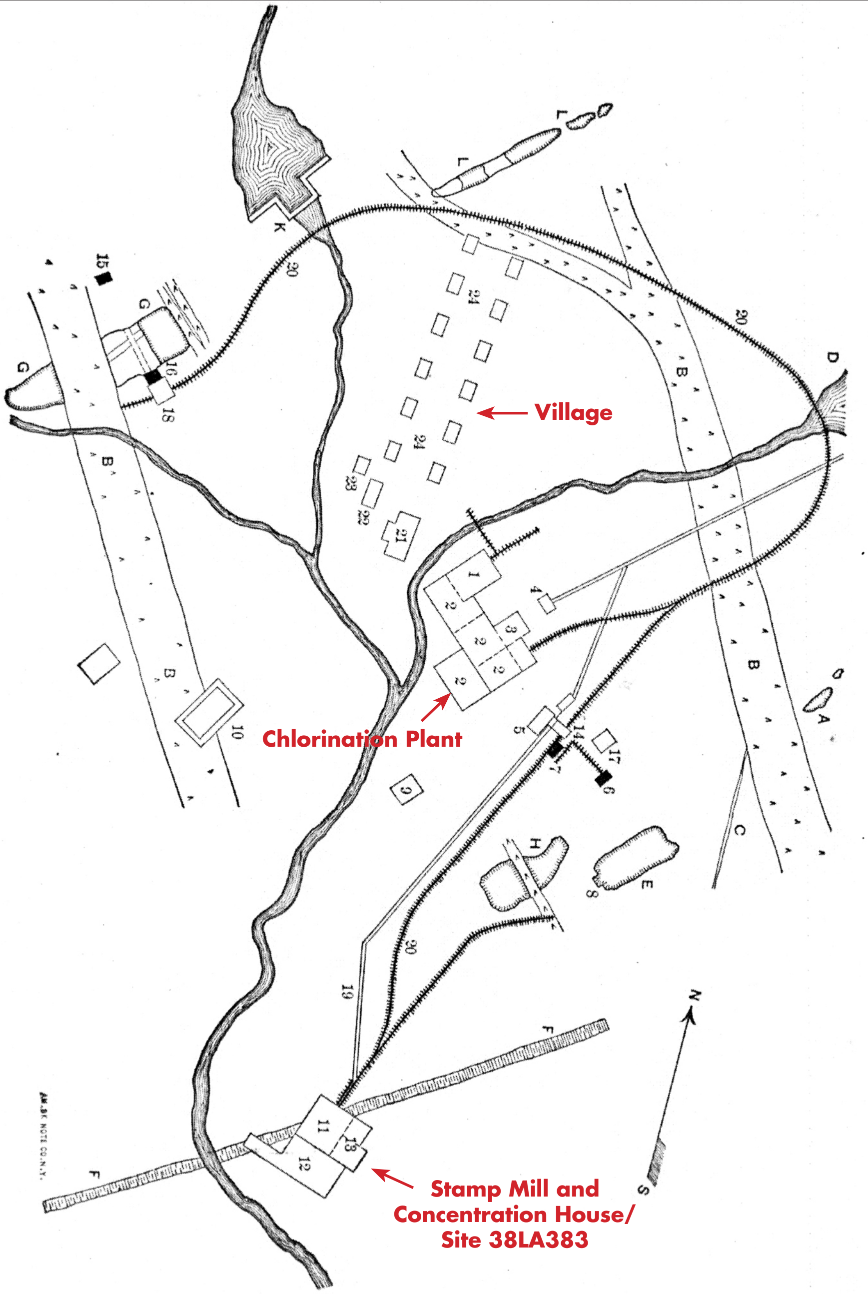
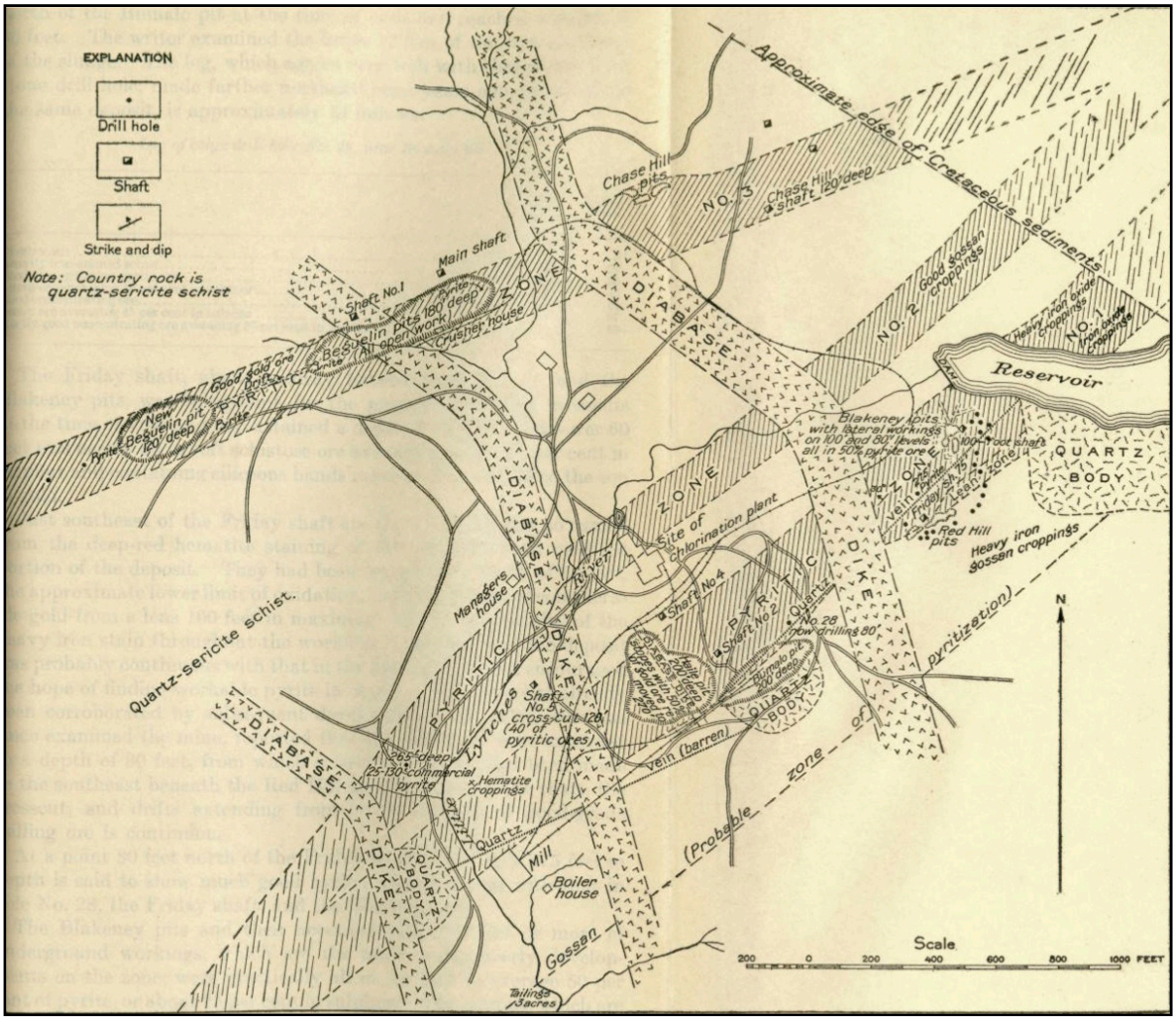


Fig. 21.—**Mines and Plant, Haile Gold Mining Co., Lancaster County, S. C. Scale, 1 inch=400 feet.**

A, Red Hill pits; B, Diabase dikes; C, clay dikes; D, outlet of large reservoir; E, Bumalo pit; F, quartz-vein; G, Beguelin mine; H, Haile pit; K, small reservoir; L, Chase Hill pits; 1, chlorination house; 2, roasting furnaces; 3, boiler house; 4, pump; 5, machine shop; 6, No. 2 shaft; 7, new shaft; 8, No. 3 shaft; 9, offices; 10, superintendent's residence; 11, mill; 12, concentration house; 13, boiler and engine; 14, crusher; 15, new Beguelin shaft; 16, Beguelin slope; 17, boiler house; 18, crusher; 19, flume; 20, mine railroad; 21, commissary; 22, church; 23, school; 24, village.

Source: Nitze and Wilkens (1897:127)

Figure 6.
Haile Gold Mine in the Early Twentieth Century



Source: Schrader 1921

This type of excavation led to a vast mine pit honeycombed with large chambers at the base or sides, a feature that was apparently unique to the southern states. As one mining engineer stated:

> When we leave the West and head South to the Southern States, such as Georgia and South Carolina, we find an entirely different condition of ore deposits, and, in consequence, a very different method of development. Here the characteristic feature is that of broad zones, it may be some hundreds of feet in width, composed of narrow lenses and veinlets of low-grade ore disseminated through a zone of schistose and slaty county rock. Such deposits have to be worked wholesale to be worked at profit, consequently, instead of the regular orthodox shaft and narrow tunnels and drifts, we find huge, open, crater-like pits 200 feet wide… by a hundred or more feet deep. In the drifts and shafts communicating with these, we find ourselves in vast, open, cave-like chambers from which the great low-grade bodies of ore have been taken, and we look up uneasily into their dark recesses, wondering how the roof keeps up, seeing there is not a stick of timber to support it, for none has so far been found necessary. We observe that the mine is supported mainly by natural pillars, as in a great coal mine; such are the striking features of the celebrated Haile mines we lately visited in South Carolina (Lakes 1900a:55).

Removing the ore from the mine involved several steps. Ore cars, with a capacity of 0.75 tons, took the ore from loading chutes to the lift point on an 18-inch gauge track. The usual hoisting method involved a 7x12-foot single compartment bucket or "skip," lifted by a cage. Thies designed a 6x14-foot triple compartment vertical skip that was in use by 1900 (Lakes 1900a:57). At the surface, Blake crushers at the edge of the mine broke the ore to sizes suitable for the stamp mill. The ore then went into bins until a small-gauge railroad took it to the stamp mill (Pittman 2008:26; Nitze and Wilkens 1897:135).

THE STAMP MILL

The 60-stamp mill was constructed and brought on line in stages. By 1890, Thies had added 20 more stamps to Spilsbury's 20. All 60 stamps were running by February 1892 (Thies and Phillips 1892:67, 72, 81). The ore was brought by rail to the third floor of the mill and discharged into east and west bins (Figures 7 and 8A). Each 150-ton capacity bin flowed to Hendy self-feeders, which in turn served the stamp batteries (Thies and Phillips 1892:73). The batteries were back-to-back, with 30 stamps per side. Each stamp weighed 750 pounds and dropped a height of 5.25 inches 84 times per minute. Each stamp handled an average of 2.01 tons of ore every 24 hours. The crushed pulp washed out of the stamp through 36-mesh brass wire screens, which had replaced slotted Russian sheet screens that were found unsatisfactory. The amount of water required for each stamp was 3.5 gallons per minute and 0.35 ounces of mercury was needed to process each ton of ore (Thies and Phillips 1892:72; Nitze and Wilkens 1897:135-136).

Mercury-coated surfaces were placed inside each mortar box and at its discharge side. The exterior attachments were the apron plates or "launderers" that captured the gold as the pulp washed out of the stamp. Each of these plates measured 50x20 inches, and they were removable and interchangeable. These were arranged in four steps or plates. At regular intervals, the plates were scraped to remove the amalgam, which was sent to a retort to distill the mercury.

Water was essential to the process and was provided by a 10-inch square wooden flume that pulled water from a dammed reservoir located about a half mile upstream on Ledbetter Creek. This water was carried to the mill by gravity flow (Nitze and Wilkens1897:135-136; Richards 1909:1622).

Amalgamation obtained an estimated 37 percent of the gold in the ore. Gold compounded with sulfur passed through amalgamation as tailings requiring additional treatment. The tailings flowed in troughs to the concentrating room where it was spread over 20 Embrey belts and six Wilfley tables that separated the gold-bearing sulfides from the gangue. The Beguelin and Cross ores were milled separately because they had substantial differences in the level of sulfides: two percent in Cross and from 7-25 percent in Beguelin (Lakes 1900a:108; Sloan 1908:74). Thies estimated that 80 tons of crushed ore yielded 7.5 tons of "concentrates," or enriched ore from which most of the waste rock was removed (Thies and Phillips 1892:72-74). He described the concentrating process at Haile as follows:

> The battery-tailings are conveyed to the concentrator through open launders 8 x 10 inches, with cross riffles, one inch high, every 8 to 10 inches. Total length of launders, 78 feet; inclination, ½ inch per foot. The launders discharge into a box from which runs a series of small launders at right angles to the main launder, to each concentrator. There are 16 Embrey end shake concentrators, 8 to each 20 stamps [before the plant was expanded to 60 stamps]. The distribution table for the battery-tailings is provided with an amalgamated copper plate for saving any free gold, amalgam or free quicksilver which may escape from the outside battery-plates. The belts are set with 2-5/8 inch inclination and travel 5 feet per minute. The number of strokes is 192 per minute. The yield in concentrates per ton of ore stamped averages 9 per cent, i.e., for each 11.19 ton stamped, there is a yield of 1 ton of concentrates. The loss in sulphurets is about 10 per cent (Thies and Phillips 1892:73).

Concentrates looked like green-yellow sand and smelled like sulfur. A rail spur from the main line served the "sulphuret shed" and took the concentrates to the chlorination plant (Pittman 2008: 32-33) (see Figure 8A).

Three boilers and a 150-horsepower Harris-Corliss engine powered the stamp mill and concentrators (Thies and Phillips 1892:72). By 1900, only two boilers were used. These were "encased in brick and concrete" and vented with a 50-foot chimney (Pittman 2008:28). Along with driving the mill machinery, it powered a dynamo that lit the mill at night (Lakes 1900b:108).

Figure 7.
Cross Section of the 60-Stamp Mill

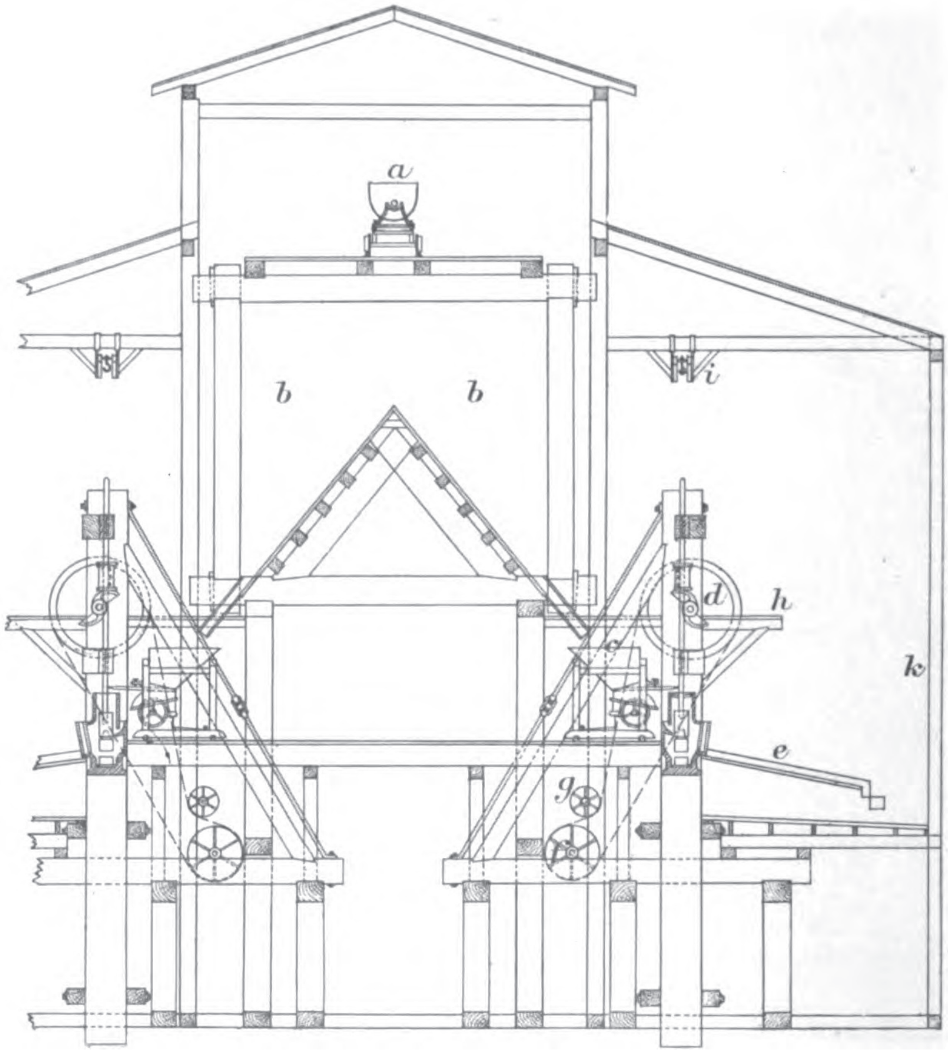
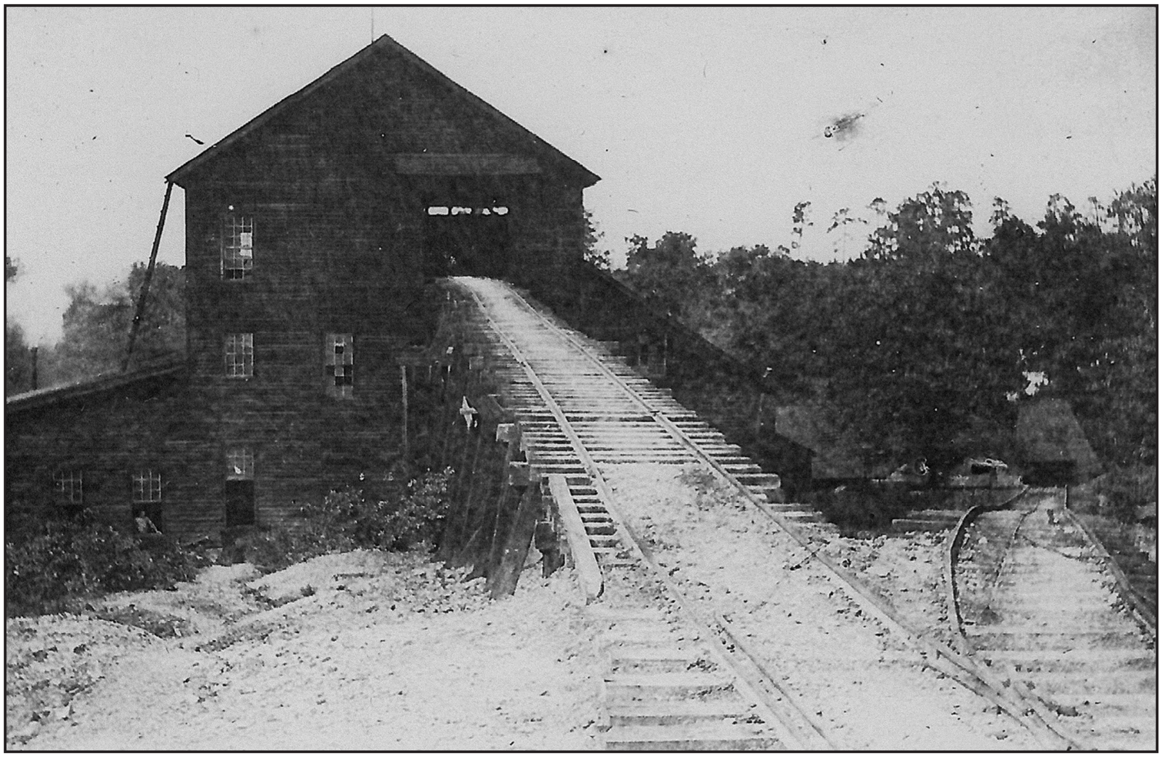


FIG. 192.—AN AMALGAMATION MILL.

Source: Lock 1901

Figure 8.
Views of the Stamp Mill



A. "Front" Showing Railroad Entering the Third Floor with the Engine and Boiler Houses at Left and Spur to Concentrating Room at Right

B. "Rear" Looking North from the Creek Side at the Concentrating Room with Boiler Room at Right

Source: Photos by John C. Jenkins, Courtesy of Tom and Dorothy Gregory

No other mine facilities or houses had electricity during this period (Pittman 2008:62). The mill ran 24 hours a day, six days a week, with a foreman, an engineer, a concentrator man, and three mill men per 12-hour shift.

ROASTING AND CHLORINATION

Concentrates went through a chemical process to extract the gold. Thies developed a variation of the chlorination process, usually referred to as the "Thies barrel chlorination process." The success of this system was essential for the overall prosperity of the mine.

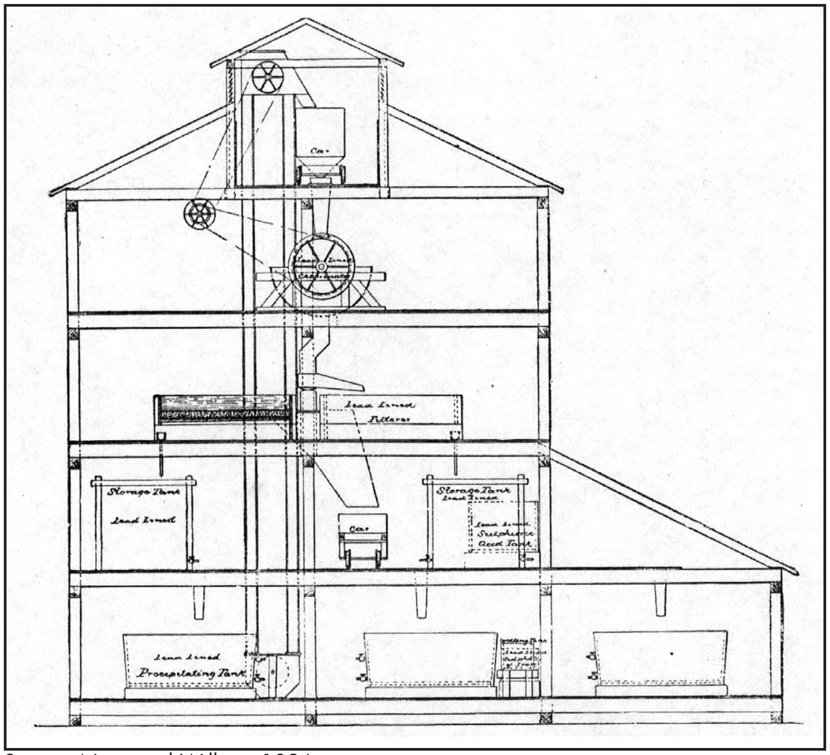
The concentrates passed through the two principal steps: roasting and chlorination. Roasting caused chemical changes that isolated the gold particles and made chlorination work (Eissler 1900:361). The average assay value of the raw concentrates at Haile was around $30 per ton, with sulfur being between 40 and 45 percent. Roasting reduced the sulfur and increased the value of the concentrates by a third to $40 per ton (Thies and Phillips 1892:74).

Concentrates went to the Roaster Plant, part of the Chlorination Plant (Pittman 2008:32). There were three furnaces: two double-hearth reverberatories and one revolving pan furnace. The reverberatory double-hearth roasting furnaces were 45 feet long, 6 feet wide, 7.5 feet high, and provided 400 square feet of roasting surface each (Nitze and Wilkens 1897). The English "pan furnace" came from Mecklenburg Iron Works. It had a 12-foot diameter cast iron frame lined with firebricks. The pan rotated during the drying process. An American Spencer furnace was also built at Haile in November of 1889, but was abandoned soon after construction, owing to problems with the rakes.

Four men staffed each furnace over a 24-hour period. Working in 12-hour shifts, they performed all the charging, firing, and handling of the ore at a rate of one dollar per man per shift. The revolving furnace could turn 3.3 tons of raw concentrates into 2.5 tons of roasted ore in a 24-hour period. When dry, the ore was raked out of the furnace onto the cooling floor. In the double hearth furnaces, the sulfides were first placed into the upper hearth for thorough drying. They then went to the lower hearth, known as the firebox, for roasting. Each of the two reverberatory furnaces could take 2.6 tons of raw concentrates and convert them into two tons of roasted ore every 24 hours. The daily total yield of roasted ore was 6.5 tons. Both types of furnace reduced the level of sulfur in the concentrates from around 43 percent to 0.25 percent (Thies and Phillips 1892:74-76; Lakes 1900b:108; Nitze and Wilkens 1897:137). The furnaces consumed around a half cord of firewood per furnace per ton of roasted ore. Local landowners provided and delivered the wood for $1.40 per cord (Thies and Phillips 1892:75-76).

After roasting and cooling, the ore was elevated 40 feet to the top floor of the five-story Chlorination Building (Figure 9). The plant initially used two chlorination barrels with a third added by 1900. In addition, there were eight filters, two storage tanks for filtered solutions, 13 precipitating tanks, two settling tanks for precipitates, one storage tank for sulfuric acid, and a tank for preparing ferrous sulfate (Thies and Phillips 1892:76; Nitze and Wilkens 1897:139-140).

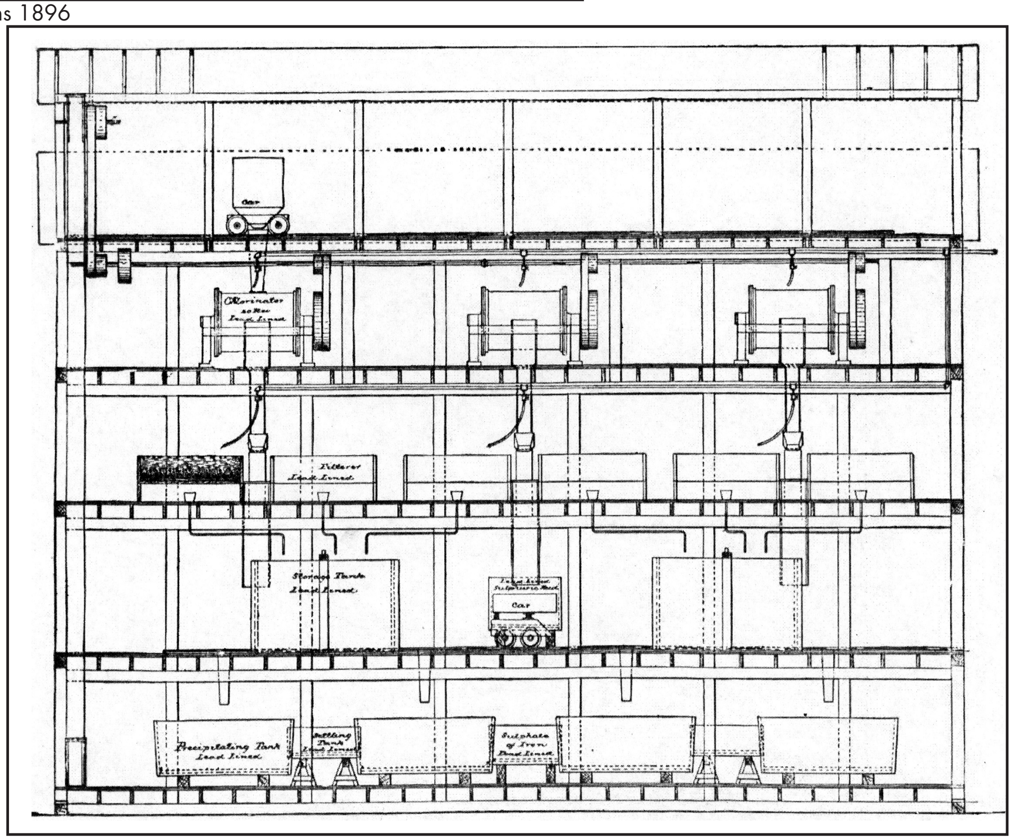
Figure 9.
Haile Chlorination Plant, Circa 1896



A. Vertical Cross Section

Source: Nitze and Wilkens 1896

B. Longitudinal Section



Source: Nitze and Wilkens 1896

The chlorination process at Haile involved mixing highly saturated chlorine-water with the roasted ore in rotating barrels. The 42-inch-diameter and 60-inch-long barrels, lined with sheet lead, had a capacity between 1.0 and 1.25 tons. An average load required 10-15 pounds of chloride of lime and 15-20 pounds of sulfuric acid (Thies and Phillips 1892:77-78). After each barrel was charged with a ton of roasted ore, 120 gallons of water were added to form a solution. Bleaching powder and sulfuric acid were added and the barrel was rolled for three hours at a rate of 14-18 revolutions per minute, driven by a five-horsepower engine (Lakes 1900b:108-109; Nitze and Wilkens 1897:141).

The gold chloride was then discharged through lead-lined, quartz-and-sand filters to precipitating tanks at the next lowest level in the plant. The precipitating tanks were eight feet in diameter, three feet high, and made of wood with asphalt lining. There, the gold was precipitated with the addition of sulfate of iron (Lakes 1900b:108-109).

The precipitate was then collected, cleaned, and sent to the smelter where it was melted in a graphite crucible, cast into gold bars, and shipped to the U.S. Assay Office in Charlotte. It usually rated at a fineness of 975-985. Between the amalgamation and chlorination, it was estimated that on average, as much as 90-95 percent of the total gold within a ton of ore was extracted (Thies and Phillips 1892:66, 78-81; Lakes 1900b:109).

THE RAILROAD

The rail system at the Haile Gold Mine was essential to the success of the mining operation, and a moderately elaborate system of mainlines and spurs were developed to shift materials around the property. The train was made up of eight cars (initially it had been seven), each with a three-ton capacity. The cars were bottom-dumpers that were driven onto the upper floors of the stamp mill to unload directly into feeder bins (Nitze and Wilkens 1897:135) (see Figure 8). The railroad line also transported the concentrates from the stamp mill to the roasting plant north of the stamp mill.

WOOD SUPPLY

The stamp mill, furnaces, and chlorination plant required a steady and plentiful wood supply. Thies arranged for William Uriah Clyburn to supply most of the fuel. By the late 1800s and early 1900s, Clyburn owned at least 20,000 acres, much of which provided Haile Gold Mine with pine. Correspondence from Thies to Clyburn between 1890 and 1892 detailed Thies' fuel orders (Thies 1890, 1891, 1892). Documents in the possession of Tom and Dorothy Gregory (personal communication, 2011) indicated that in 1891, Clyburn provided the mine with 5,000 cords of wood from his lands and another 2,500 cords from adjacent properties, including land owned by Haile Gold Mine. An agreement between Thies and Clyburn stipulated the wood was to be cut four feet long and split if it had a diameter of six inches or more. Clyburn received $1.75 for each cord (Articles of Agreement 1891). These documents suggest that Haile was one of the main sources of income for the Clyburn plantation.

THE TOWN OF HAILE GOLD MINE

In the late 1800s and early 1900s, the mine complex grew into "Haile Gold Mine," a regularly constituted town with its own post office. The village, as it was labeled on maps, included the large Thies family residence as well as numerous other cottages, a school, a church, a post office, and the company store (see Figure 5). The houses, school, and church clustered on a no-longer extant road that Pittman (2008) labeled "Newberry Street." Certain individuals and their families lived apart from the main village. The Thies residence, for instance, was southwest of the Village along with the houses of Adolph Thies, Jr., and William "Will" Jenkins, assistant mine superintendent and underground mining engineer. Joe Poinsett Pittman, who ran the boilers and the engine room from 1897-1908, and John Byrd, mechanic and underground pump superintendent, lived in houses just west of the stamp mill (Pittman 2008:vii).

The houses and the other buildings almost certainly belonged to the Haile Gold Mining Company. Local tax records for 1905 show that the company still owned the original 1,805-acre tract. The company also had 21 buildings, with the value of the land and the buildings placed at $7,065. Considerably more was invested in personal property, machinery and equipment: around $17,000 (Pittman 2008:81).

In later years, Pittman estimated that the Haile Gold Mine had a labor force of around 175 people. Of that number, 100 were laborers paid a dollar a day; 25 were skilled workers or specialists, paid $1.50 per day; another 25 were office workers, supervisors, foremen, and bosses who were paid $2 per day. The final 25 were lumped under miscellaneous help, maintenance, and supply at $0.80 per day (Pittman 2008:79). The stamp mill operated continuously day and night, but it is not certain that this was the case at the mine pits or some of the other facilities.

The Thies House was the home of Carl Adolph Thies until his retirement in 1904. Afterwards, his son, "Capt." Ernest (Ernst) A. Thies took over management of the mine and moved into "The Big House," as it was called. Another son, Adolph "Dolph," Jr. served as an assistant. There were two other sons: Gus, who did exploratory diamond drilling at the mine, and Oscar, who was mostly away at school. Carl Thies, Sr. had one daughter who married W.T. Wohlford, the mine's bookkeeper and paymaster (Pittman 2008:41-42).

After retirement, Adolph Thies moved to a home he built at the edge of the prestigious Myers Park neighborhood in Charlotte, North Carolina (Gaither 1977). Ernest Thies, a graduate of the Colorado School of Mines, formally became general manager at Haile, although he might have assumed effective control of the mine before then. His brother Dolph continued to conduct the drilling, surveying and assaying (Pettus 2011; Sloan 1908:59).

The Thies residence became the showpiece of the community. A bachelor and man of good habits, Ernest was known to be strict, fair, and honest. The grounds of the house, which were immaculate, included a hothouse, where Thies grew roses. He used these to make a balm called "Thies Salve," considered effective on skin rashes. Thies lived well and had servants, including his own cook, an African American named Bell Horton (Pettus 2011; Pittman 2008:39).

Other prominent people who worked at the mine included Mid Truesdale, the Concentrator Room supervisor killed in the 1908 explosion. His brother, Jesse, was the Concentrator Room foreman. Other members of this family included L. E. Truesdale, a machinist, and Hamp Truesdale, the mine's hoisterman (Pittman 2008:42-43).

In many ways, Haile Gold Mine was a regular South Carolina community. At least three people in town drew Confederate pensions from the state: M. H. Bowers (Co. H, 2nd SC Volunteers), age 63; Eliza Rowell (husband in Co. E, 22nd Reg.), no age given; and Elizabeth Ellis (husband in Co. B, 26th Reg.), age 73 (Reports and Resolutions 1905:124-125). Many of the miners at Haile were African American, and at least some appear to have lived in the community (Pittman 1908:21-23).

There was a relatively well-known court case that involved the community, when Charlie W. Roach sued Haile Gold Mining Company for using a defective skip car to transport employees. According to Roach, the company knew the car was defective but failed to tell the riders. This case ultimately went to the South Carolina Supreme Court, but the final outcome was not in Roach's favor (Southeastern Reporter 1905:543).

Other towns also grew up in the vicinity at about the same time. In 1887, when the railroad was extended from Camden to Marion, North Carolina, the railroad added a stop between Camden and Lancaster at the urging of Capt. James V. Welsh of the Pleasant Plains community. The town that sprang up around the train stop was first called "Welsh's Station," but Welsh himself suggested that the name be changed to Kershaw in honor of Major General J. B. Kershaw of Camden, a figure prominent in the Civil War. James Welsh served as the first mayor of the town. Many of the people who worked at the mine lived in Kershaw, and some walked to and from there every day (Pittman 2008:37). By the early 1900s, Kershaw could boast some rather large industries: Springs Cotton Mill and Kershaw Oil Mill, the latter founded by John T. Stevens, who became involved in the history of the Haile Gold Mine after the explosion of 1908.

EXPLOSION AND AFTERMATH, 1908-1911

After operating without any major problems for 16 years, the 60-stamp mill was destroyed in a massive explosion shortly after 9:00 am on August 10, 1908. One of the two 150-horsepower boilers blew up, sending metal, brick and concrete through the entire stamp mill complex (Figure 10). Clyde Pittman, who witnessed the explosion, reported that the smokestack was hurled 100 feet into the air (Pittman 2008:71-72).

A number of people were injured, but two were mortally wounded: Mid Truesdale, the Concentrator Room supervisor, and Ernest Thies, the mine manager. Workmen using blown-out doors as stretchers, took both to their respective homes, where they later died of their injuries. Ernest Thies was only 40, but he was more than the manager of the mine. He was the one person who held the operation together and made it profitable. His death destroyed the future of the mine.

In the aftermath of the explosion, the stockholders of the Haile Gold Mining Company, most of whom were in the New York City area, decided to discontinue the mine (Gaither 1977). This decision, however, was not conveyed to the mineworkers. Letters written to L.W. Ammerman,

Figure 10.
The Stamp Mill After the Boiler Explosion, August 1908

Source: Photograph by John C. Jenkins, Courtesy of Tom and Dorothy Gregory secretary of the Haile Gold Mining Company in New York, asking for information about the mine's future, received no reply. To everyone's surprise, the mine simply ceased operations. Without the mine, the local community soon collapsed. The local post office closed on January 31, 1909 (Pittman 2008:21, 78-79, 82).

For Pittman (2008), it was always a puzzle as to why the mine was simply allowed to die rather than attempting to rebuild the mill. In the end, it became apparent that the mine's profit margin was much thinner than people thought. Too much material had to be moved and processed for a return of too little gold. The viability of the chlorination process might also have influenced the decision.

By the late 1890s, chlorination had begun to fall out of favor as a method for extracting gold. In 1898, one mining engineer reported that chlorination was the preferred method for treating auriferous concentrates obtained from the tailings of stamp mills, "except in districts where smelting works, producing mattes or base bullion, exist." Improvements to the barrels boosted the popularity of the chlorination process, and in some places barrel size was increased to accommodate 10 tons, much larger than the barrels used at Haile. Even so, the machinery was costly. While chlorination was still common in North America at the turn of the twentieth century, it was declining in other areas where it had once been popular, such as in Australia.

The new method gaining favor was cyanide, which could be used on the ore in open vats and without rotation. It was an easier method with fewer mechanical problems. Even the chlorination process was simplified by using larger vats, some up to 25 tons, and chlorine water, a weaker solution than chloride of lime. These improvements appear to have first been adopted in Australia, where "American methods" of chlorination were abandoned by 1898 (Rose 1898:316). The cyanide process rapidly replaced chlorination and remains the most common method in use today.

For these reasons and perhaps others not understood, the Haile Gold Mining Company simply folded in the years following the explosion. On June 20, 1911, the property was put up for public sale by decree of the Circuit Court of Common Pleas. L.W. Ammerman and Charles D. Jones, receivers for the Haile Gold Mining Company, sold the mine and its 1,805 acres to John T. Stevens, president of the Haile Gold Mining Corporation, for $69,000 (Lancaster County Deed Book S-2:555). Stevens, who was already a prominent businessman in the area, steered the Haile Gold Mining Corporation in new directions in the years to follow. The mine was reopened periodically, but only under lease arrangements with other firms, until after World War II.

HAILE GOLD MINING CORPORATION AND ITS LEASES, 1911-1946

John T. Stevens, president of the Haile Gold Mining Corporation, was born December 1, 1869 in Lancaster County. He began work as a store clerk, and by age 22 he was in the lumber business. There he made money and eventually became president of the Kershaw Mercantile and Banking Company, followed by the Bank of Kershaw. He expanded his interests to cottonseed oil and quickly became president of the Kershaw Oil Mill Company. Soon he was president of the South Carolina Cotton Seed Crushers Association. Stevens was also president of many other firms, one of which was the Haile Gold Mining Corporation (Snowden and Cutler 1920:44-45). Stevens may have been in charge of the Haile Gold Mine, but it was certainly not his major concern.

Stevens and the Haile Gold Mining Corporation attempted to reopen the mine. In 1912-1913, they constructed a small cyanide plant to reprocess tailings left from the previous mining operation. The project was abandoned after a few months (Bradt and Newton 1940). During its brief period of operation, it was recorded that, "Haile Gold Mine is in operation again, and other undertakings in the matter of gold deposits in the State are operated in a more or less desultory manner" (Commissioner of Agriculture, Commerce, and Industry of the State of South Carolina 1913:268).

During World War I, mining resumed at the Haile Gold Mine, but for pyrites used to make sulfuric acid, a solvent needed in heavy industry. A.K. Blakeney received the first pyrite lease, awarded in August 1915 and lasting until June 1917. At that time, Kershaw Mining Company took over the lease and worked the mine until the end of the war, when the price of pyrites collapsed. Joel Watkins, onetime superintendent of the pyrite mine, described the situation at the site when the Kershaw Company took over the property. He noted that Haile Gold Mine had accumulated considerable "equipment, such as boilers, engines, hoists, compressors, stamp batteries, crushers and tables . . . about one mile of light rail, one small saddle-tank locomotive, a number of ore cars, a machine shop and a number of good houses." He added, "Much of the material is in good repair and is being used, though a large amount is obsolete and has gone to the scrap heap." In addition, the stamp mill was remodeled for pyrite by replacing the stamps with jigs, rolls, and crushers (Watkins 1918:520). Illustrations of the rebuilt mill showed the east side and concentrating room repaired after the explosion as well as a large bin or other structure built on the front (north) side of the building (Figure 11). The mill was intended to concentrate 300 tons of pyrite ore per day, but reportedly never operated at capacity throughout its lifetime of March to November 1918 (Bradt and Newton 1940).

Although the Haile Gold Mine operated under two separate leases during the war, it appears that the same people ran the actual operations. A.K. Blakeney had the first lease but he was also affiliated with the Kershaw Mining Company, which obtained the second lease. The address for the Kershaw Mining Company was given as A.K. Blakeney of Kershaw, South Carolina, or J.H. Watkins, 200 5th Avenue, New York City (Weed 1920:1315-1316).

The rocks at the mine were described as sericite and quartz-schists. Pyritization was common, and the schists in particular were impregnated with pyrite. The quantity of sulfur in these schists ranged from 25 to 30 percent. The equipment used at the mine was described as a complete mining plant, which included a 300-ton mill with crushers, rollers and jigs. These produced a concentrate with around 47 percent sulphur (Watkins 1918:518-519; Weed 1920:1315-1316).

In 1922, the publication *American Fertilizer* discussed the nature of the Haile pyrite deposits, specifically mentioning that the local pyrite was diffused in a gangue or sericite and quartz matrix. The pyrite was further described as very fine-grained and relatively pure, becoming better in quality with greater mine depth. It was noted further that the deepest workings at Haile reached a depth of 350 feet. The descriptions of the mine appear to refer to workings conducted during the war. It was believed that pyrite mining had barely tapped this resource; an estimated 600,000 tons were thought to still lie in the ground. This quantity would be about half of the amount used every year by the United States for arms production and agricultural fertilizer (*American Fertilizer* 1922:34).

Figure 11.
The Kershaw Mining Company Remodeling of the Stamp Mill for Pyrite Concentrating

A. View to the North Showing Repaired Mill and Concentration Shed

A. View to the Northeast with the New Ore Bin on North Side of Mill

Source: Watkins 1918

The Haile Gold Mine does not appear to have been worked significantly after the war until 1934, when Haile Gold Mines, Inc. obtained the property under a lease-purchase contract from Haile Gold Mining Corporation. This time, gold was sought, its price having risen during the Great Depression. The first task of the new operation was to dewater the pits, which had filled with rain and ground water (Bradt and Newton 1940). By early 1935, a 100-ton pilot mill was completed near the Beguelin pit to determine the best operational technique before building any permanent facilities.

Between February and April 1935, this plant processed 18,000 tons of crude ore and another 15,000 tons of older tailings. The pilot plant used simple amalgamation plates without any other process for the sulfides and it was estimated that only 17 percent of the total gold was recovered (Gaither 1977; Bradt and Newton 1940).

After a testing period in 1936, an "all-sliming" 125-ton cyanide plant was built between January and June of 1937. Put into operation that June, the plant precipitated the first gold the following month. Soon, there was a new skipway, headframe, hoist, and storage bin adjacent to the Beguelin pit. The "all-sliming" method of cyanidation was based on a continuous counter-current decantation. The first unit of the mill was designed to process 125 tons in 24 hours, but it was soon discovered that the facility could handle 175 tons during the same period. Power was provided with a nine-mile, 13,200-volt line that furnished electricity after a step-down to 440 volts (Gaither 1977; Bradt and Newton 1940).

Little is known about this mining operation. An annual report on the "Haile Gold Mines, Inc.," dated to 1939, mentioned some of the features of the mining operation. There were two relatively new cyanide units, the staff house, several dwellings, a laboratory, roads, a new dam to replace the one washed out in 1938, and a series of new mill buildings, including a storeroom, lime house, repair shop, and powder magazine. Various parts of the mine were identified by name, including Beguelin Pit, Red Hill, Chase Hill, Clyburn, Amalgamation Tailings, and the Old Haile Dump. Apparently, much of the mine's efforts were directed toward reprocessing tailings from older works. The annual report stated the cyanide plants were installed "to treat the amalgamation tailings impounded from the pilot mill operations" (Haile Gold Mines, Inc. 1939). Years later, it was estimated that during the period from 1934-1942, Haile Gold Mines, Inc., produced more than 58,000 ounces of gold using amalgamation plates and the cyanide process (Atkins 1992).

The mine closed again in 1942 due to labor shortages brought on by the Second World War and War Production Board Limitation Order L-208, which required nonessential gold mines to shut down so that the labor and equipment could be put toward activities deemed more necessary. Despite the option to purchase, the property remained in the possession of the Haile Gold Mining Corporation, which sold off the equipment to a defense plant in Alabama (Bradt and Newton 1940; Gaither 1977; Pittman 2008:4, 66; Pettus 2011). The mining operation came back after the war, but the emphasis was less on gold than sericite, a form of mica sold under the name of "mineralite," used as filler for paper, paint, wallboard, roofing, rubber, and brake linings (Pettus and Bishop 1984:196).

POST-1946

On June 21, 1946, Haile Gold Mining Corporation sold the mine and its 1,805 acres to James P. Beckwith of Vance County, North Carolina, for $165,000 (Lancaster County Deed Book T-3:399). That same day, Beckwith deeded to Haile Mines, Inc., the land that was immediately around the mine pits and the mining complex, identified in a special survey as containing 287.93 acres. The deed for the 287.93 acres was transacted for $1 (Lancaster County Deed Book T-3:412). Beckwith sold the remaining 1,517 acres to Kershaw Oil Mill for $13,594.27 that same year (Lancaster County Deed Book V-3:208). This represented the first division of the Haile Gold Mine property in nearly 100 years. The 1946 plat of the 287.93-acre Haile Mine tract is the instrument that is constantly cited in subsequent years, serving as a reference point in an almost bewildering array of transactions and mergers after 1946.

Mineral Mining Corporation obtained a lease on the property in 1947 (Lancaster County Deed Book Z-3:493), but apparently did not develop it significantly, if at all. In 1956, the tract was the subject of a timber sale (Lancaster County Deed Book M-4:320).

On August 16, 1963, Mineral Mining Corporation purchased the 287.93-acre tract, as well as other properties, from the Howe Sound Company, formerly Haile Mines, Inc., for $40,000 (Lancaster County Deed Book F-5:334). Mineral Mining Corporation later became MMC Holding Inc. Piedmont Mining Company acquired the land around 1984 and began operating the mine by the following year. MMC Holding held on to at least some of the surrounding property until April 30, 1990 and then sold it along with other tracts to the Mineral Mining Company, Inc., (MMC) (a wholly owned subsidiary of Piedmont Mining Company Inc.) for an undisclosed "full value" (Lancaster County Deed Book C-9:142). During this period, there was considerable exploration of the area, done by Piedmont Land and Exploration (later Piedmont Mining Company, and by Amax Gold Exploration Inc (a wholly-owned subsidiary of Amax Gold Inc.).

In July of 1992, there was a joint venture agreement between Amax Gold Company (Lancaster Mining Company, 62.5 percent) and Piedmont Mining Company (37.5 percent). On October 6, 1992, Mineral Mining Company, Inc., changed its name to Kershaw Gold Company, Inc., when MMC was sold back to its previous owner (Lancaster County Deed Books B-11:218; 457:34). Later that year, on December 30, Kershaw Gold Company joint ventured with Lancaster Mining Company, Inc. The next day, Lancaster Mining Company created Haile Mining Company, Inc. to manage the property for the venture (Lancaster County Deed Books B-11:218; 229:102, 105; 457:34). In 1998, Lancaster Mining Company purchased Kershaw Gold's portion of the venture and then dissolved Lancaster Mining into Haile Mining Company, Inc. Finally, on October 15, 2007, Haile Mining Company, Inc., deeded the 287.93-acre tract to Haile Gold Mine, Inc., for $5 and other considerations (Lancaster County Deed Book 428:234). Haile Gold Mine, Inc., is a subsidiary of Romarco Minerals, Inc., which owns the property today.

Relatively little mining activity took place at Haile Mine between 1946 and 1984, but it picked up in the years that followed. The Piedmont Mining Company of Charlotte owned and worked the mine from around 1985 to around 1992. During this period, Piedmont extracted approximately 85,000 ounces of gold from the mine. In 1992, Amax Gold and Piedmont began a program of exploration and development drilling, property evaluation, mineral resource estimation, and project feasibility studies. Feasibility studies completed in 1994 suggested the property contained a reserve of about 75,000 ounces of gold. Kinross Gold Corporation acquired the mine in 1998 and later took over Piedmont's interest and initiated closure activities (Atkins 1992; Romarco 2008; Crowl et al. 2009:1).

In 2007, when Romarco took over the property, there were only four employees at the mine. Three years later, there were 57 employees and 28 contractors. With the new facilities that were planned, it was anticipated that the number of people working at the mine would rise to 500 during the new construction period, dropping to 250 permanent employees and 40-60 new contractors to run the new mine facilities during regular operation (Faris 2010).

The new proposed operation will remove more gold from the ground than Thies and those that came before him could have imagined possible. Even so, Haile Gold Mine was good to its past owners. In 1940, it was estimated that the mine, which then covered a four square mile area, probably processed over one million tons of ore, with an average extraction rate of around 70 percent and an estimated yield of $4.5 million since the beginning of the mine (Bradt and Newton 1940). Adolph Thies and his sons probably recovered he majority of this total. This is not a bad return for any Southern mine, and this was why Haile has always been in the forefront of the many gold mines scattered across the central Carolinas.

DEVELOPMENT OF HAILE GOLD MINE: SUMMARY AND INTERPRETATION

The preceding historical overview provides a basis for understanding how Haile Gold Mine developed over time. The following discussion, based on historical descriptions and maps, summarizes the mine's growth and changing character as a basis for understanding how the mine's owners and managers handled its mineral resources as well as how they organized and ran its development over time.

Development of Haile Gold Mine began with the initial gold discoveries, presumably in placer deposits along Ledbetter (present-day Haile Gold Mine) Creek. It is unclear how extensive placer mining was because sources indicate that lode ore was discovered soon afterwards. However, the early development of the site probably resulted in a typical prospecting-placer mining landscape characterized by various small circular and larger oblong and linear tailings composed of stream cobbles. Miners using varieties of hand tools to excavate and process gold-bearing deposits probably dominated the scene, with the main processing equipment being pans and different types of rockers (Tuomey 1848:279-280). Also, as the initial finds probably spurred a general search for sources, the initial prospecting and mining activity was probably more widespread than later. The overall scale of these activities is not clear, though; insofar as is known, Benjamin Haile was the sole operator at the mine and the discovery of gold did not spur a rush.

Lode mining began in the 1830s and focused on specific locations. These sources required excavation and mechanical processing. Benjamin Haile's approach to managing the mine was to lease plots to local planters or "small irresponsible companies" (Lieber 1858:62) who operated open pits and cuts, and separated the gold from the gangue using arrastras, Chilian mills, and Cugnot's five-stamp mill. The 1850 plat (see Figure 4) provides a rough illustration of Haile Gold

Mine during this period. Although not to scale, the plot shows several pits in a single area on both sides of Ledbetter Creek. Given the distribution of gold sources at the mine, and the locations of later excavation areas, it is probable that the plat illustrates the two zones at Haile where replacement deposits occurred and that eventually developed into the Haile and Bumalo pits to the southeast and the Beguelin Pit to the northwest.

The plat also indicated how some activity areas at the mine were organized. Two gold mills appeared on the plat, one at the open cuts, and the second labeled, "Kagnot's" [Cugnot's], to the south and on the west side of Ledbetter Creek. This pond presumably served as a reservoir to power and feed Cugnot's mill. The actual location of this mill is unknown, and because the plat does not have a scale, its location must be projected from landmarks, which suggest two possible locations. One is at the confluence of Ledbetters Creek and Little Lynches Creek, about 1.4 kilometers (0.9 mi.) southwest of the extraction pits. No extraction is known to have taken place n this area, and it is unclear why the stamp mill would have been located at such a distance from the main works. An alternative location is just south of present-day Gold Mine Road, where modern topographic maps show a small pond. This location would be closer to the mines (about 500 meters [1,640 ft.]), although not particularly convenient. Placing the stamp mill here, though, would take advantage of the local terrain. In this case, the stream valley widens slightly, while immediately downstream from the pond, a ridge spur pinches off the valley. This situation would create a natural catchment for a pond to power the mill and deliver water for the stamping process.

The second mill shown on the plat was adjacent to the mines, although its exact location cannot be determined. The device in use here was almost certainly an arrastra or Chilian mill (described in Chapter IV). Based on Tuomey's (1948:96) description, Haile at this time had begun to take on the qualities and appearance of a more mature mining landscape with old abandoned works seen along the ridges and oxidizing piles of waste pyrite scattered among them. Ten years later, the mines had mostly gone inactive, although a few people continued working the tailings of the older operations (Lieber 1858:62).

The overall scale of the operations at this point is not known. Tuomey (1848:285) indicated that nearby Brewer's Mine employed over 100 hands during the mid-1840s, along with numerous carts, rockers, horses, and mules. This was evidently one of the largest operations in the state at the time. A smaller operation, Fair Forest in Cherokee County, used eight hands and five mules, who operated two mills. The size of the works at Haile is difficult to judge without specific information because the leasing arrangement was unique in the region and individual operators could organize their labor and equipment as they wished.

Haile continued to operate through the antebellum period and Civil War, although no information was found concerning its organization or any improvements or developments. It is reasonable to assume that this period reflected one of continuity or decline in terms of organization and scale. The gold industry throughout the Carolinas mostly declined in the last years before the Civil War (McCauley and Butler 1966:11; Knapp and Glass 1999:43), and there is no reason to believe that Haile was an exception. The most significant development over this time was the destruction of whatever mining activities and equipment remained by Union Soldiers in 1865.

The period after the Civil War saw the re-establishment of mining operations. Phineas Tompkins acquired the property and rebuilt it for gold production. Descriptions of Tompkins' efforts suggest a general picture of the operation. Census data from 1870 listed a water-powered mill, six stamps, one amalgamation [plant?], one concentrating [plant?], one pump (probably to drain the mines), and a tailings pond. The location of these is not known, although it is probable that the mines themselves were located at the northwest and southeast zones. Further, as discussed above, Tompkins appears to have invested in the development of hydropower and may have built the two reservoirs at the north and east margins of the mine. The equipment listed indicates that Tompkins tried to extract the ore through amalgamation, a process that involved crushing the host rock to release the encased gold and then capture it on tables coated with mercury (see Chapter IV). The byproduct from this process typically contained minute gold particles that could be enriched with the concentrators—of unknown type—and then subjected to additional extraction procedures. Given the mineralized type of deposits at Haile and the general exhaustion of placer and vein sources, Tompkins probably planned to institute chemical methods as well.

E. Gybbon Spilsbury took over as general manager 1880 and began extensive improvements in an effort to profitably extract gold from the mineralized country rock. Although the changes Spilsbury made are documented, there is little information on the spatial organization of the property during this time and no maps. However, because Spilsbury's successor, Carl Thies, probably built upon the framework Spilsbury developed, the earlier situation can be extrapolated, at least generally (see Figure 5). Also, it is known that Spilsbury's stamp mill was the same one that Thiess took over and enlarged (later designated Site 38LA383). Therefore, maps of the property during Thies' management period provide reference for understanding Spilsbury's operation.

By the time Spilsbury arrived, extraction was firmly established at two or three principal surface cuts and possibly some outlying prospects. Spilsbury instituted underground mining, placing shafts near the existing open cuts. As noted, the main extraction sites were about 1,500 feet apart to intercept the gold-bearing zones. Branches of Ledbetter Creek crossed between these areas, forming a Y-shape with the mines occupying level to moderately sloping high ground on either side.

Spilsbury arranged the processing operation between and around these principal features (the mines and stream branches). He put the stamp mill about 500 feet southwest of the Haile and Bumalo pits in the southeast part of the property, a position that was located somewhat conveniently for these mines but quite a distance from the northwestern mines. The placement of the stamp mill thus does not appear to have been especially practical. Ideally, stamp mills were located to make delivery of ore convenient and economical as well as to facilitate moving the output to the next processing stage and/or waste areas. Proximity to a water source was also important. If the later maps reflected the layout Spilsbury established, then the roasting and chemical processing were located in the area between the mines. This arrangement required raw ore to be hauled to the edge of the mining property for stamping while the resultant tailings had to go back into the center of the property for further processing.

This convoluted plan might have been due to Spilsbury's establishment of a mining community at the site. The village was built on a high ridge in the top part of the "Y" formed by the creek and its branches. Stamp mills were extremely loud and protection from sound could have influenced their locations (or the placement of the residences) (Gonzalez-Tennant 2009:31). Spilsbury might have intended to provide some noise buffering by placing the stamp mill at a distance from where the village was established. Also, the stamp mill lay at the foot of a slope facing west-southwest into the stream valley, with the ridge between the mill and village, an arrangement might have provided some sound buffering.

Spilsbury also organized the small-gauge railroad used to transport ore and materials within the property, and improved hoisting systems for the underground workings. During the 1880s, Haile Gold Mine took on a more industrial character than it probably had in the past, with an integrated system of extraction and processing as well as various auxiliary activities and related structures.

This arrangement existed through the end of the 1800s and left a lasting imprint on the landscape. The organization of activity areas during the years Carl and Ernest Thiess managed the mine probably followed the plan that Spilsbury established, at least in a general way. Thiess expanded the stamp mill that Spilsbury built, and therefore its location was stable. The other processing areas in the center of the site were probably in the same approximate location between the two mines, although their exact locations are not known.

Under the management of Carl Thiess, the arrangement of the property most likely built upon the foundations established by Spilsbury, possibly with some modifications. The Thies period is relatively well documented in terms of the use of space, most of which has already been discussed. Further interpretations are possible because the locations of certain features Thies put in place or used are known for certain, based on the contemporary map by Nitze and Wilkens (1897) and Schrader (1921), which shows the mine around World War I when many of the older gold mining buildings and equipment were still present.

The most important element of the Thies era was the chlorination plant, which combined roasting, chlorination, and power generation into a single complex (see Figure 4). This was located in the center of the property, between the Haile/Bumalo pits in the southeast and the Beguelin Pit in the northwest. With the stamp mill located to the southwest, ore still had to be hauled from the mines to the margin of the property and then back to the center. The stamp mill's location, as noted, might have been for sound buffering. At the same time, it is worth considering why roasting and chlorination were not then placed at the stamp mill to make transportation easier as well as to create a more logical forward progression.

The modern topographic map suggests that the arrangement of the mining complex might have related to the terrain. The overall setting of the mine is rolling, with high, broad ridges and moderate slopes. The valley of Ledbetter (Haile Gold Mine) Creek is generally narrow and deep with restricted terraces. The chlorination plant location, however, was a relatively wide and level section of the valley and was the only such area in the mining property, except for ridge tops. The principal advantage of placing the plant on high ground would have been the ability to arrange it to use gravity for moving the process forward. However, various arrangements were possible and plants could be built on level ground (Richards 1909). A sloping position would not necessarily be preferred, moreover, if it required construction of an inclined tram to deliver the ore (Wilson 1897:100). At Haile, the roasted ore was moved to the top of the multi-story chlorination building with a single elevator, which let it flow downward through the process. The location in the valley bottom also allowed for water to be brought along the valley with an aqueduct from the reservoir east of the mine. A further advantage of this location was that its width allowed for the development of a tailings pond, which maps of the 1940s showed just downstream from the chlorination plant (Pardee and Park 1948; McCauley and Butler 1966). Finally, the location let the rail connection between the stamp mill and chlorination plant follow a relatively level grade that would not require excessive power to haul the ore uphill.

Other developments that Thies put into place included more elaborate mining and preliminary ore dressing facilities. The mineshafts were outfitted with inclines that hauled up the ore in self-dumping skips (designed by Thies) that serviced crushers and ore bins over the mine railroad. These received power from dedicated steam plants at each facility (Nitze and Wilkens 1896). Thies also put into place or continued to use the railroad and water supply. The small-guage rail line used to move materials around the mine consisted of a 0.7 mile-long loop that passed from the Beguelin Mine in the northwest, around the village, past the crusher of the Haile and Bumalo mines, and then to the stamp mill. Spurs serviced the chlorination plant and Hail Pit. This route passed the Chase Hill Pits to the north, which Thies closed, and that therefore suggest the rail route was established earlier. The line crossed the creek in two locations, apparently on large trestles (Pittman 2008). The mine also used an extensive aqueduct or flume to carry water from the reservoir east of the site to the chlorination plant and stamp mill. At the flume's terminus water was stored in a smaller reservoir to use in the stamp mill. Finally, under Thies, the area peripheral to the chlorination plant also contained shops, offices, a retort and assay shop, and gold scales. The overall effect of these developments was to increase the sense of an industrial operation started under Spilsbury's tenure.

The general arrangement of Haile Gold Mine established during the last decades of the nineteenth century persisted through its closure after the boiler explosion in 1904 and the reopening during World War I as a pyrite mine. Some of the buildings remained from the gold operation, and the stamp mill was reconditioned to process pyrite. Schrader's (1921) map of the site shows the mill, the railroad, and a few other buildings, along with the open pits and several shafts. Schrader illustrated the "Site of the Chlorination Plant." None of the other structures are labeled as the "site of," suggesting the plant might have been removed or abandoned by this time. Overall, the 1921 map indicates a much smaller scale of operations focused on the mines producing the ore and the stamp mill, which was involved mainly in concentrating the ore for shipping. The workers' housing was mostly gone—a few unlabeled buildings were shown in this area—along with several of the other auxiliary structures (see Figure 6).

A notable change between the 1890s and 1921 maps was that the later map showed an elaborate road network across the mine property. This development is notable for reflecting an important aspect of the mining industry in the early twentieth-century: the use of trucks instead of carts and trams to move materials within and around the mines. Rail transportation remained in use at this time, but mainly to deliver raw ore to the stamp mill. From here, the finished product was loaded into trucks for delivery (see Figure 11B).

Two maps illustrate the mine during the 1930s when it was converted again for gold production. McCauley and Butler (1966) reproduced a map of around 1940 that illustrated buildings erected after 1935. Pardee and Park's (1948) map post-dates the other one, although a note indicates the geology was mapped in 1935. Both maps show essentially the same activities, and date to the time the Haile Gold Mining Corporation developed the property for cyanide extraction. An additional point about Pardee and Park is that their publication contains two maps at different scales that show slightly different versions of the site. A smaller-scale map shows the old stamp mill, for example, while the large scale map does not. Neither map shows the chlorination plant and indicates the area where it had been located was covered in "Recent alluvium."

Nevertheless, the three different maps show a distinctly new arrangement of activities at Haile Gold Mine. By this time, the areal extent of the mine had consolidated to the area around the Beguelin Pit in the northeast. Excavations had been expanded here during the early part of the century to include a "New Beguelin Pit," which was shown on the 1921 map, and the original pit was subdivided to include a new opening called the Blauvelt Pit. The main activity area was also located here, focused on the mill and cyanide plant. Several auxiliary structures were concentrated here as well, with a scatter of other important buildings located south and east. These other buildings included a shop, office, and assay lab located in the vicinity of the Haile and Bumalo pits, which hint that some mining was still underway at these workings as well, or that they were re-using older buildings from the Thies period. Pardee and Park (1948) showed a large building labeled "Store" in the same location that it appeared on the 1896 map (see Figure 5) along with a few other buildings that lie in the vicinity of the earlier workers' housing.

The 1940 map showed more of the infrastructure related to worker support and other activities. This map included several small buildings scattered in the area between the two mining zones that were labeled "Residence," "Staff cabin," or "Staff house," while a single structure was labeled "Tennis court." Other structures included a "Cotton house" and "Mule barn," which indicated the continued use of draft animals through the early part of the twentieth century. The purpose of the cotton house is unknown. Notably, this latest map did not show the original stamp mill, but only labeled its location as "Site of old mill," indicating it had been removed or at least abandoned by this time.

In summary, the layout and organization of Haile Gold Mine provided suggestions as to how miners understood the resource, how mining activities were organized, and how these changed over time. This review of the changing landscape at Haile provided a basis for understanding certain specific aspects of the stamp mill, its location, and how it related to other elements of the overall mine complex. The next chapter discusses in detail how gold mining was conducted and the role of the stamp mill in extracting gold from lode ore.

IV. THE METALLURGY OF GOLD

Nearly every common gold mining method used during the nineteenth and twentieth centuries was employed at Haile Gold Mine. Although Site 38LA383 reflects only one aspect of a larger process, the purpose of the site can be better understood with reference to the general procedures of gold mining. Certain aspects of these processes were described in the preceding chapter with reference to particular historical developments. The following discussion provides a general overview of gold mining processes and how they relate to one another. The purpose of this discussion is to provide a context for interpreting the stamp mill, and therefore exploration and prospecting are not addressed.

Mining and handling ores is generally divided into three principal stages: extraction, beneficiation, and refining. Extraction refers to the removal of minerals from the earth. Beneficiation is the process of increasing the proportion of valuable ore by removing it from its containing rock. Refining is the process of converting the mineral into a state of purity suitable for industrial use, manufacturing, or commercial exchange (Noble and Spude 1997).

EXTRACTION

Extraction falls into two classes: surface and underground mining. The method used depended on the physical location of the desired ore and available technology. Historically, surface mining was used for minerals at shallow depths or those accessible at natural cuts such as along stream valleys. Surface mining for gold commonly involved placers consisting of loose, water-deposited sands, gravels, or other alluvium containing free gold particles (Hardesty 2010:34). Placers typically occur in stream valleys, but might also be in higher elevations where they were deposited in older landforms. Small placer deposits were most often mined through simple hand-dug pits or burrows (CALTRANS 2008:86). Surface mines, however, are often pits such as those associated with twentieth-century operations at Haile Gold Mine.

Underground mining was undertaken to reach deeper ores. The technology and methods used depended on the geology of the ore body as well as the engineering techniques considered best to extract the ore while maintaining safety and productivity. The simplest underground mines consisted of a single horizontal adit or vertical shaft. This form of mine was known as the "rat hole" system, and was more typical of small-scale operations. "Planned mining" involved more elaborate networks of adits, shafts, drifts, crosscuts, winzes, and raises, as well as ventilation, drainage, and other features (Hardesty 2010:38, 41-43).

Miners had specific terms for various kinds of underground workings. "Shafts" refer to vertical openings from the surface. "Adits" were horizontal openings from the surface, most often excavated into a slope. "Drifts" consisted of horizontal openings dug from the side of a shaft. "Crosscuts" were horizontal tunnels running at angles to the axis of the ore body. "Winzes" were shafts dug downward within the mine from a drift or other horizontal opening. "Raises" comprised vertical shafts dug upward to connect different levels of a mine's interior. The exterior entrance to a mine was the "portal." "Tunnels" were horizontal passages open at both ends. An individual mine could contain several of these features in combination.

Subterranean mine systems might also include "stopes," large open spaces for extracting ore that were often stepped to access an inclined ore body. "Rooms" were similar to stopes, and were distinguished as open spaces abutting an entry or airway to a face. Rooms were usually separated by "pillars," consisting of areas of ore left to support the overlying strata. Pillars were typically excavated after work in the rooms was complete. These more elaborate systems were used at Haile Gold Mine during the nineteenth and early twentieth centuries.

Whether a mine was underground or at the surface, it required means to remove the ore and transport it to the mill or plant for processing. Methods to transport people, equipment, and supplies were also necessary. The simplest methods of hoisting involved having the miners carry ore containers and gear up and down ladders. Mechanical equipment included windlasses powered by hand or animal, which were used through at least the mid-nineteenth century. By the late nineteenth century, Haile Gold Mine used steam engines to pull ore cars up inclines. In the twentieth century, petroleum and electric power was introduced for this purpose. More elaborate structures included headframes, consisting of tower-like structures built over the mineshaft. Powered winching mechanisms raised and lowered a cage from a pulley mounted in the top of the tower (Hardesty 2010:49-51). At the Haile Gold Mine, inclined tracks were used to pull skips filled with ore from the mines at least during the later nineteenth century, while transportation used through the various processing activities was by a small-gauge railroad. Early methods are not known, but almost certainly involved human and animal-powered systems.

BENEFICIATION

Beneficiation refers to the process of separating valuable minerals from the worthless portion of an ore (gangue) and concentrating the valuable portion into smaller bulk and weight (Richards 1909:1; Allen 1920:4). In general, ore handling is also termed "concentrating." Gold occurs as loose particles or as inclusions within a surrounding matrix. Free gold has eroded from host rock and is most often found in placers or as constituents of weathered rock/saprolite. Relatively large gold particles can also be encased in other minerals and are released by breaking and crushing. For example, it commonly occurs in quartz rock from which the sulfides have been removed by leaching, leaving only the quartz, fingers or veins of free gold, and iron oxides. Finally, gold occurs in sulfides, which consist of compounds of sulfur with more than one element (Thrush 1968). In this context, gold is typically distributed as minute particles (Eissler 1900: 6), which make it more difficult to free and sort from the gangue. Different beneficiation procedures were developed to handle and recover gold from these different kinds of conditions. Hayward (1952) categorized these processes as mechanical methods, amalgamation, hydrometallurgical methods, and smelting. The first three were employed at Haile Gold Mine, while smelting was an end point to amalgamation and hydrometallurgical methods.

MECHANICAL METHODS

Mechanical methods involve using the specific gravity of native gold to separate it from waste materials. The simplest techniques for gold mining, these methods were usually used on placer deposits and supplements to other methods. The essential procedure was to place gravel, sand, and soil into a container, add water, and agitate the mixture, which allowed the lighter waste materials to float or wash out while the heavier gold particles sank. Panning was the most basic form of concentrating but was limited in the speed and volume of material that could be processed (Figure 12).

Improved devices included rockers, sluice boxes, and variations such as the "long tom." Rockers consisted of boxes mounted on curved wooden runners (the "rockers") and having an open front. The top of the box had a perforated bottom and below this was a backward-sloping baffle board or canvas apron. The bottom level contained riffles. To operate, the miner put gravel in the top level and ladled water over it while manually rocking the device. The baffle board deposited the screenings to the back of the lower level and as they washed out the open front, the riffles caught the heavier gold particles (Richards 1909:323-324).

Another device, the sluice, consisted of a flat-bottomed trough or chute through which water mixed with sand and gravel flowed. Water continuously flowed through the sluice while sand and gravel were shoveled in. Riffles built into the floor of the sluice created a suspension that allowed the lighter materials to wash out while catching the heavier gold flakes. The "long tom" utilized a similar principal, but consisted of a trough with a screen or perforated metal plate (the "riddle") at the outlet end. Sand and gravel were shoveled into the trough and agitated as a continuous stream of water washed through, carrying smaller particles through the riddle and into a lower tier with riffles that caught the gold. Sometimes mercury would be added to the riffles to amalgamate with the gold and make it easier to collect (The Colliery Engineering Company 1899; Richards 1909:322; Gregory 1907:7; Hayward 1952:426). The use of long toms was reported for antebellum mining at Haile Gold Mine, and it is likely that the other common methods were used as well.

AMALGAMATION

Amalgamation involves creating an alloy of gold and mercury to remove gold from gangue. The principle of amalgamation is that gold bonds to mercury. Common practice involved washing gold-bearing pulp (a mixture of water and ground ore capable of flowing) over a surface coated with mercury or amalgam. The gold was recovered from the amalgam by distilling the mercury in a retort and smelting the gold to remove residual impurities (Hayward 1952:430). Before reaching this point, the ore had to be reduced in size, a process conducted in one or more stages.

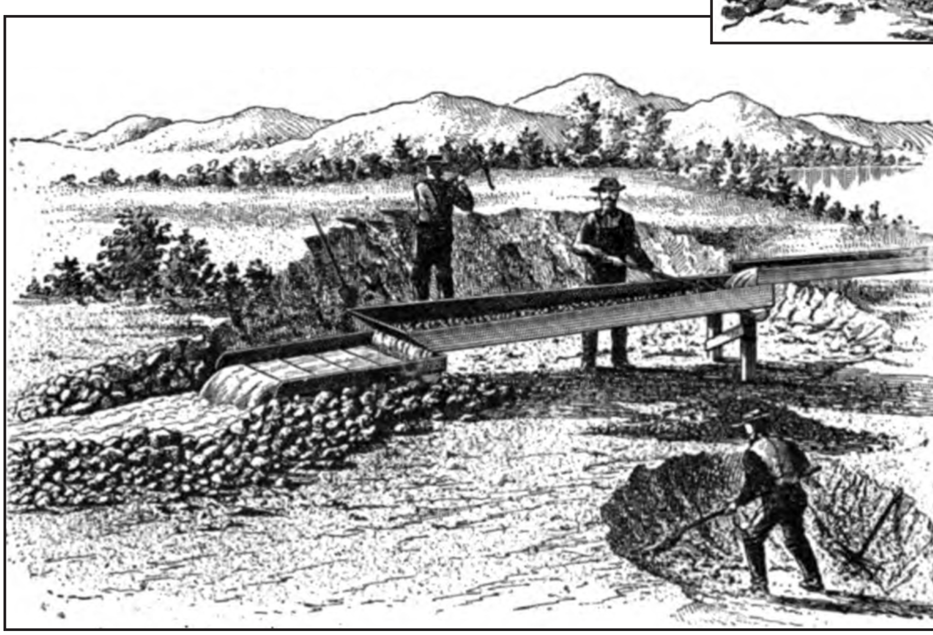
Breaking and Crushing

Although crushing ore could be an end stage in gold mining, it was nearly always a first step in extracting "rebellious" ores that were encased in hard rock or sulfides. As a stand-alone process, miners simply crushed the rock and collected the freed gold particles, commonly with one of the

Figure 12.
Common Mechanical Methods of Gold Recovery

A. Panning

B. Rocker or Cradle Rocker



C. Long Tom

Source: The Colliery Engineering Company 1899 methods described above. For amalgamation and hydrometallurgial processes, breaking and crushing was meant to reduce the rock for the machines that would handle it later, and to generate particles of a uniform size for subsequent treatments. Breaking was usually the first step, while crushing and grinding applied sequentially, produced particles the size of coarse sand or smaller ("slime"). This process of reducing and regulating the size of the ore fragments was known as "comminution" (International Library of Technology 1902:25.1; Thrush 1968).

Preliminary breaking reduced the ore to sizes appropriate for the crushing machines and/or enhanced its friability. Methods included blasting, calcining by fire, hand hammers and rock breakers. Blasting and hand hammering are self-explanatory. Other devices included jaw breakers, comprising hinged crushers that operated intermittently as the jaws opened and closed, and spindle or gyrating crushers that ran continuously as rock was fed from an ore bin (Lock 1901; International Library of Technology 1902; Richards 1909; Hardesty 2010:67). Breaking took place underground at the mine, at the top level or surface of the mine, at the mill, or in a separate dedicated structure (Hardesty 1988:39).

At Haile Gold Mine during the 1880s to early 1900s, this step was accomplished with Blake jaw crushers established at two separate locations, one at the No. 2 Shaft and the other at the Beguelin Shaft. Blake-type jaw crushers consisted of crushers with one fixed jaw plate and one that pivoted from the top that provided the greatest movement on the smallest lump. Blakes were the original jaw-type crushers (Thrush 1968). It is unknown how this was accomplished at the earlier workings, although descriptions of the antebellum activities suggest hand hammering was most likely (Figure 13).

From the preliminary breaking, the ore went through processes that crushed or ground it into pulp that could be washed across the amalgamation plates. Common early, or "traditional," devices for this were arrastras, Chilean mills, and stamp mills. Arrastras were relatively simple devices (Figure 14). Often described as "primitive," were used in Mexico by Spanish mining operations as early as the 1500s and persisted at small-scale operations in the American west into the twentieth century (Kelly and Kelly 1983:90; Van Bueren 2004; Hardesty 2010:17). Arrastras measured from 8-20 feet in diameter and varied in depth. They consisted of circular rock-lined pits with a central column. Large stones slung from horizontal poles fastened to the column were dragged around the arrastra to pulverize gold-bearing rock (Thrush 1968; Hardesty 1988:39). Before grinding the ore had to be reduced to relatively small pieces. Near the end of the grinding cycle, mercury was added to form an amalgamation. When complete, the pulp was let out of the arrastra and the amalgam was collected with sluices, cradles, or long toms. The process required considerable energy to operate and treated only low quantities of ore. To make a profit, relatively rich ores were necessary along with low investment and overhead costs (Kelly and Kelly 1983:86; Van Bueren 2004:7-8).

Chilean, or chili mills, resembled arrastras, consisting of circular enclosures with a stone or iron base or die. The principal difference was that Chilean mills used vertical rollers that ran around the enclosure to grind the ore. Two variations existed; the first having the rollers gyrate around a central point, and the second having the base or a pan revolve around the central axis, which

Figure 13.
Blake Jaw Crusher Like Those Used at Haile Gold Mine

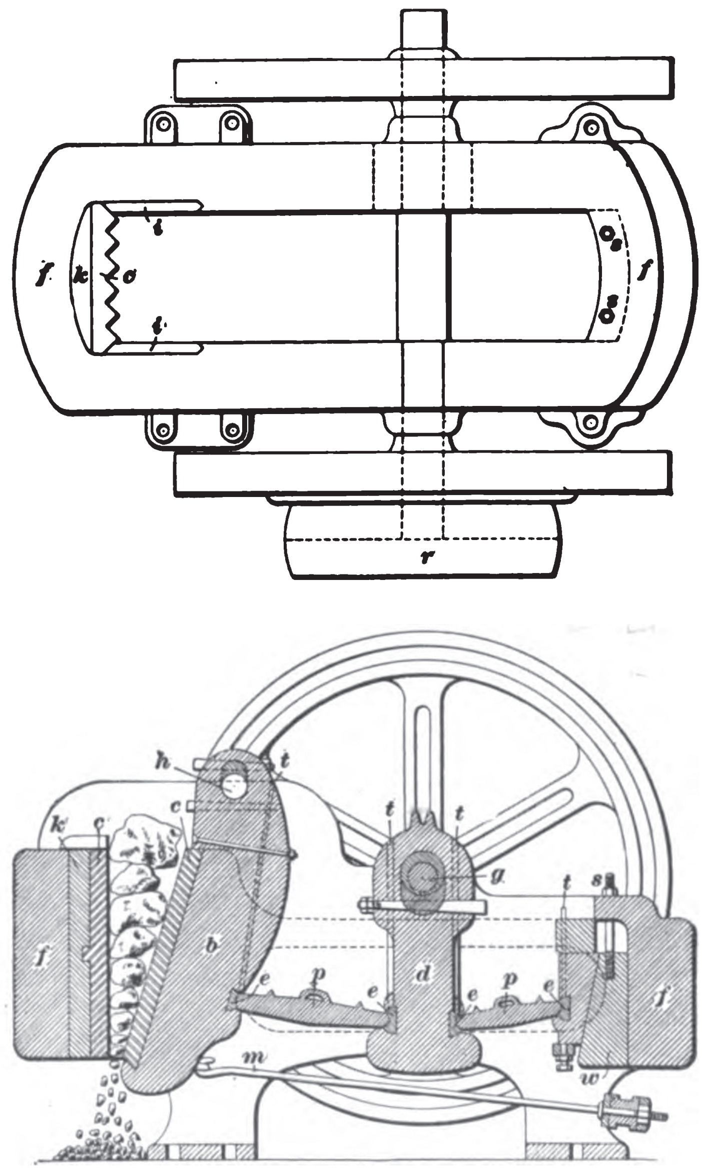
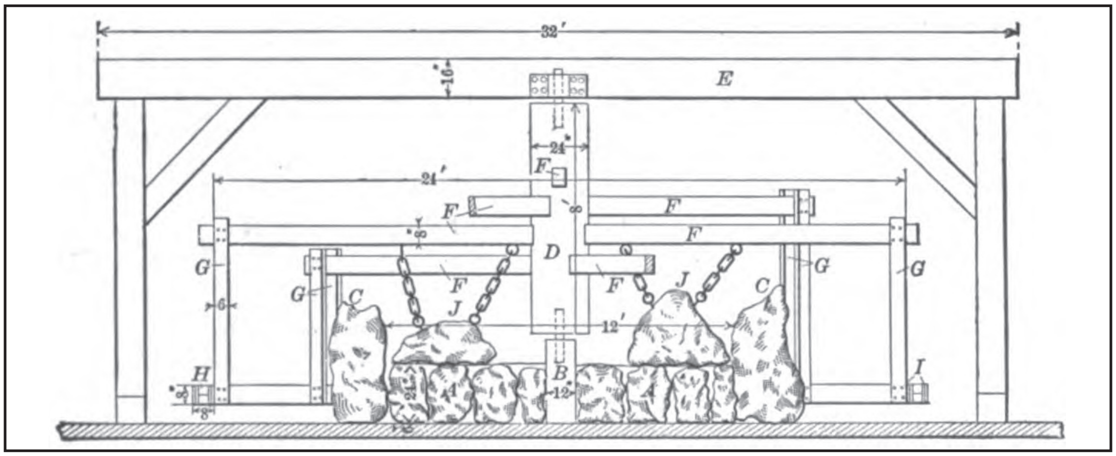


FIG. 1

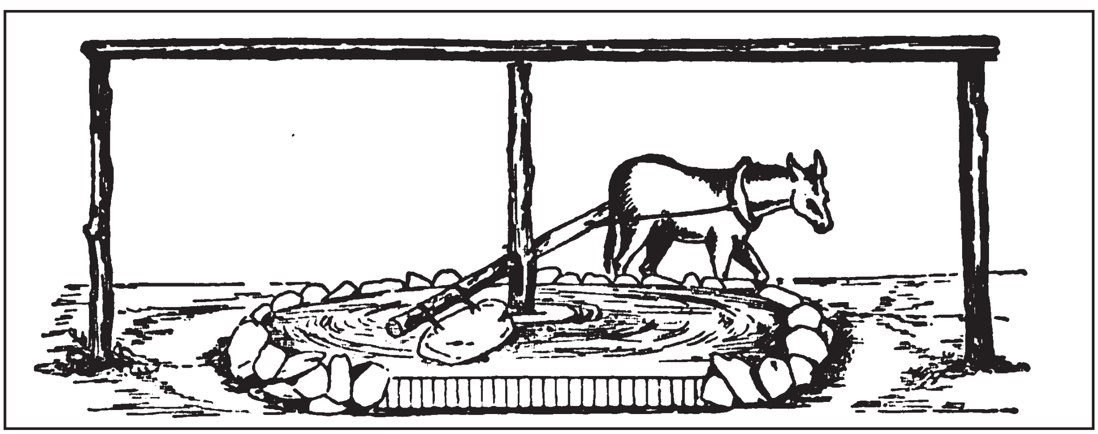
Source: Library of Technology 1902

Figure 14.
Drawings Depicting an Arrastra



A. Vertical Cross Section of an Arrastra

Source: Richards 1909



B. Diagram of An Animal-Powered Arrastra

Source: Rose 1898

caused the rollers to rotate (Thrush 1968). Early versions had one stone to rotate while later varieties had two or three wheels with iron ties driven by water or steam (Richards 1909:152). Although they reflected an early technology, versions of Chilean mills remained in use through the nineteenth century. Antebellum mining at Haile Gold Mine reportedly used either arrastras or Chilean mills. It is unknown if, after crushing the rock, the miners simply collected the particles with pans, rockers, sluices, or if they proceeded with amalgamation.

Later devices for producing finely crushed slimes included a variety of grinding pans, tube and ball mills, roller mills, and pulverizers. These worked on different principles. Grinding pans had a heavy steel disc bear down on the ore as it rotated above a fixed plate. Tube and ball mills were cylindrical contains that rotated on a horizontal axis. Along with the ore, the mill contained stone or steel balls or rods that ground the ore as the machine rotated. As the ore achieved the desired size it discharged through metal screens (Richards 1909; Hardesty 2010:69). These devices turned out the finely ground product from which very small metal particles could be recovered.

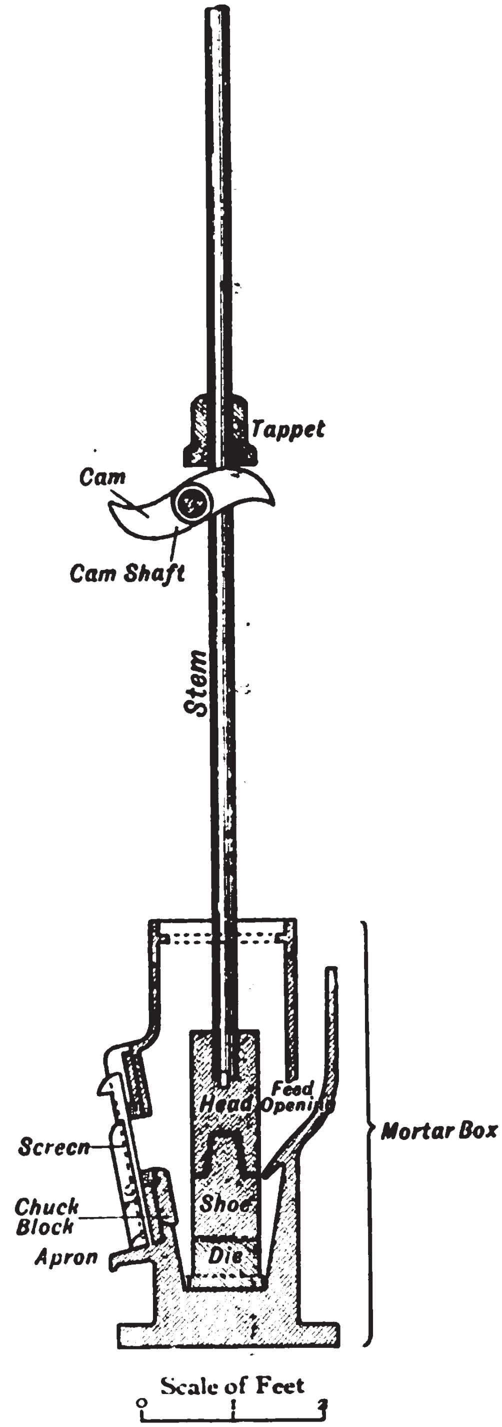
Stamp Mills

Stamp mills were the most common mechanized device for crushing gold-bearing rock in the nineteenth century. Miners from Cornwall introduced these devices to American goldfields and the improved American versions were sometimes referred to as Cornish stamps. Stamp mills involved having a battery of heavy weights lifted by cams and then dropped on the ore, crushing it against a die (Richards 1909; MacFarren 1910). They were often used in conjunction with amalgamation systems, although early operations might simply run the pulp through sluices to recover gold loosed by the stamps (Quivik 2003:8). Because Site 38A383 comprises the Haile Gold Mine stamp mill, it is worthwhile to review in detail how these operated.

The basic features of a stamp mill included the stamp, the mortar, and the lifting mechanism (Louis 1902:122) (Figure 15). The stamp consisted of a vertical steel rod ("stem"); a heavy steel weight at the lower end, composed of the "head" and "shoe;" and a collar or "tappet" about mid-way up the shaft. The stamp was suspended in a wooden or metal guide. Ore crushing took place in a container called a "mortar box," which had a feed opening, or hopper, for ore to enter and a screen across the discharge opening. Crushing took place on a die at the base of the mortar box. Mortar boxes were commonly sized to fit a row of three to five individual stamps. A camshaft fitted with S-shaped cams extended across the stems just below the tappets. A pulley or spur wheel turned the camshaft, causing the cams to engage the tappets, push the stamps upward, and then let them drop. The cams were usually arranged to fall separately in the order of 1-3-5-2-4. Ore was fed through the hopper with water and was crushed as it passed across the die. Once it reached the appropriate degree of fineness, it splashed through the screen and onto the apron plate at the front of the mortar box (Louis 1902; Gregory 1907:27; Hayward 1952:430).

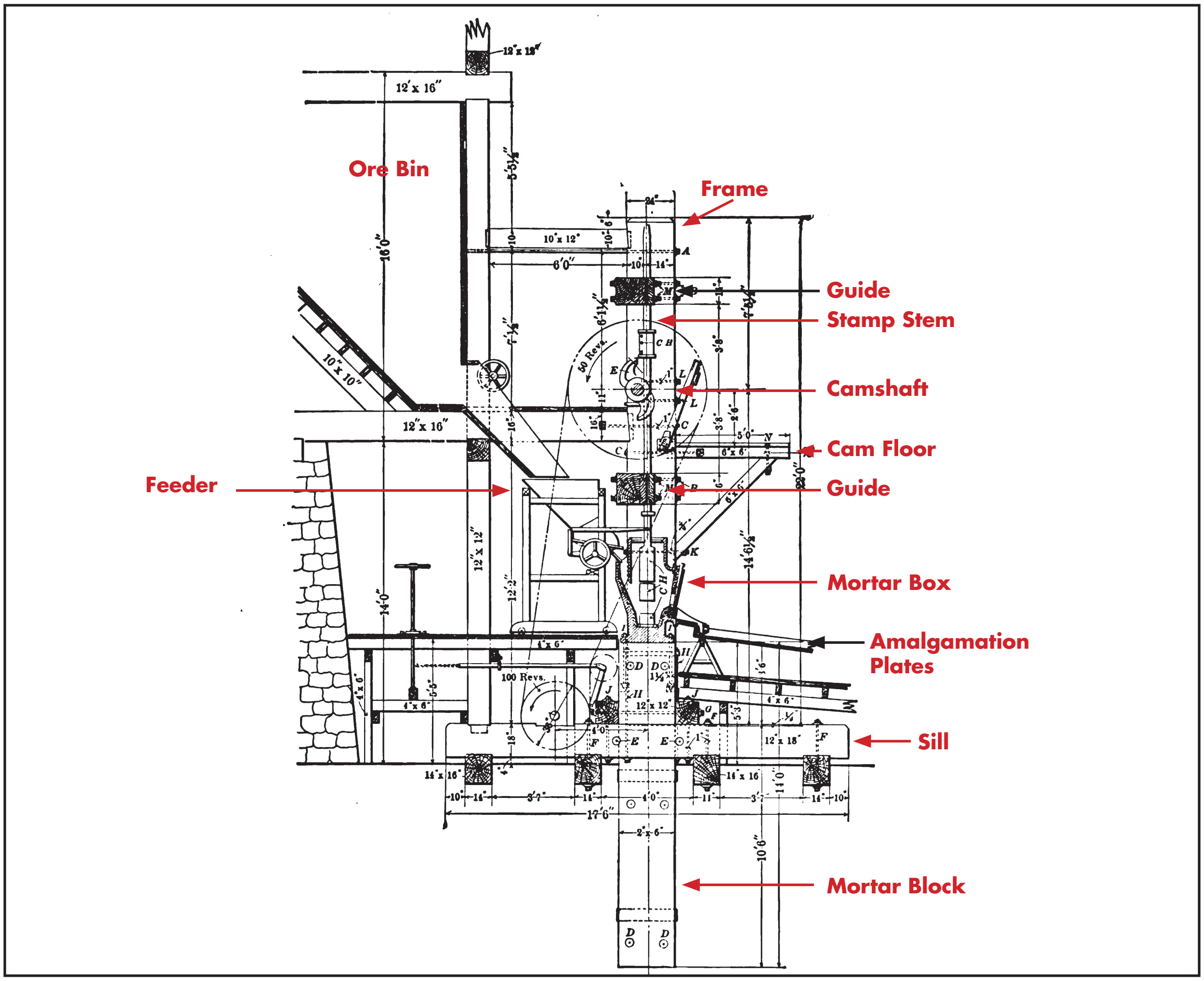
Stamp mills, or batteries, were huge multi-floor structures supported by large wooden frames and blocks to absorb the pounding (Figure 16). The above ground portion of the mill could measure approximately 20 feet high and about 15 feet wide, including the drive pulley, for a five-stamp mill (Roberts 1909:87). The stamps were framed in massive structures designed to hold the camshaft

Figure 15.
Basic Features of a Stamp Mill



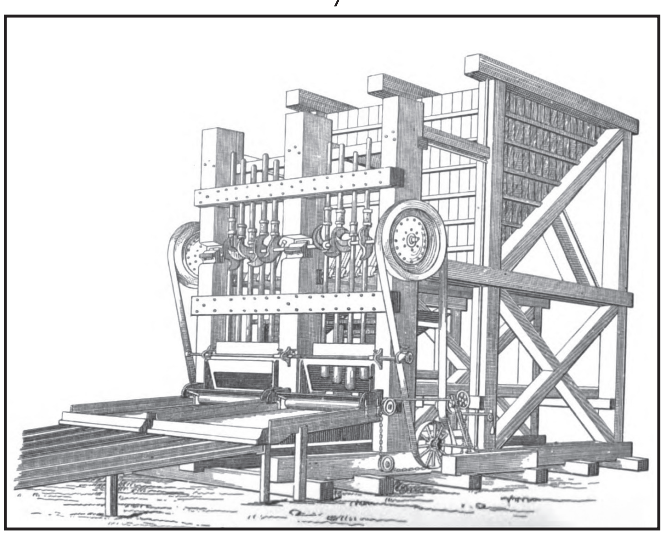
Source: Gregory 1907

Figure 16.
Stamp Mill Batteries



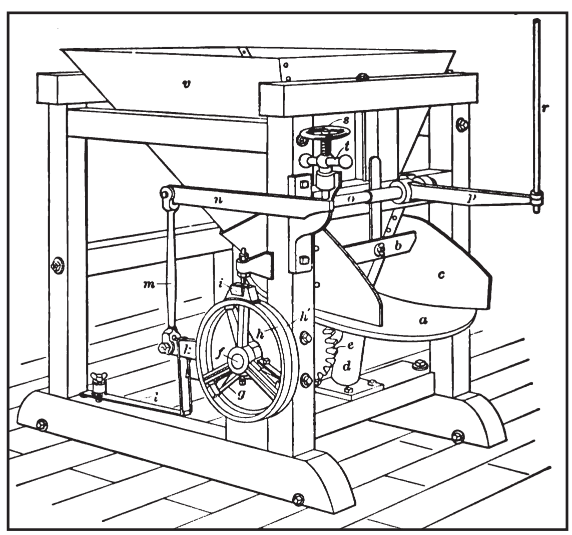
A. Side Elevation of a Battery

Source: Richards,1909



B. Ten-Stamp Battery with Amalgamation Plates, Ore Bin, and Framing

Source: Allen 1920



C. Diagram of the Hendy Challenge Ore Feeder

Source: Richards 1909

and guides for the stems. Built of wood, cast iron, steel, or wrought iron, the structure had to be extremely rigid and durable to withstand the constant hammering and the pull of the belt on the gearing. The usual arrangement consisted of two uprights for up to five stamps mounted on a horizontal sill. A third upright was added for a battery of 10 stamps. The uprights were connected with upper and lower guide beams through which the stems rose and dropped. Struts or more elaborate framing provided strength against the tension of the belt (Louis 1902:230). In addition, a platform or "cam floor" was added to the upper part of the uprights to give workmen access.

The battery sat on the mortar block, which was typically built of logs, timber, or planks placed on end and bolted together until the early twentieth century. Logs measured 8-15 feet long and 15-20 inches square. They were arranged to break joint and form a block between 20 and 30 inches wide by 48-60 inches long. Transverse straps of wood and iron were also added to the lower portion of the block to provide a wider base and assist in holding the block together. The blocks were set in custom-excavated trenches, which ideally were dug into solid rock or were supported with rock or cement retaining walls. The bottom was rammed with cement, and after the block was installed, the space between it and the trench walls was filled and rammed as well (Louis 1902:123-125; Roberts 1909:85).

The stamp mill at Haile Gold Mine contained 60 individual stamps. These were arranged in groups of six five-stamp batteries, with two rows placed back-to-back facing the exterior walls of the mill. A cross-section of the mill provided by Lock (1901:716) indicated that the batteries were supported with relatively simple framing consisting of a strut placed on the backside of the structure, which supported against the pull of the belt (see Figure 7). This arrangement was preferred in a mill operating mechanical ore-feeders, such as the Challenge feeders that Haile used (Louis 1902:232) (see Figure 16C). The cross-section further shows the extensive pilings used to support not only the stamp batteries, but also the floors for the amalgamation tables, feeders, ore bins, and railroad. Lock (1901:717) commented, "the whole structure is carried at an abnormally high elevation above ground level, or that a lavish use of pile timber has been made in the foundation without any obvious purpose."

Amalgamation took place simultaneously with stamping. The process entailed crushing the ore as described previously, and then placing the pulp in contact with mercury through various methods. The most common way was to wash the pulp from the mortar across copper tables or plates coated in mercury. A variant was the blanket table, consisting of a sluice-like device covered with wool. The heavier gold particles would settle into the wool and be recovered (Hardesty 2010:70).

The amalgamation process included the following fundamental steps. First, the ore was fed continuously into the stamp mill, sometimes with mercury added to increase the time the ore was in contact with it. The stamp mill had apron plates or tables affixed in front of the screens. These had copper or brass surfaces coated with mercury that formed the amalgam with gold particles washing out of the stamp. The interior of the mortar box might also be fitted with mercury-coated plates to increase the rate of amalgamation. At regular intervals, usually daily, the stamps were stopped to scrape the amalgam from the plates with a piece of hard rubber. The mortar boxes were cleaned as well, and if they were being used, the inside plates were scraped and/or replaced. If amalgamation plates were not inside the mortar box, the residual sands would be collected and treated separately. To recover the gold, the amalgam was squeezed through canvas or chamois to strain out as much free mercury as possible and the remaining amalgam was put in a retort to distill the mercury, which could then be reused (International Library of Technology 1902:28.14-15; Louis 1902:310, 430; Richards 1909:103-106; MacFarren 1910; Hayward 1952:432-433).

Although not part of the stamp mill, retorting was an important component of the amalgamation process. The retort was a cast iron kettle with a tube that carried away the mercury vapor. These could be relatively small and portable or permanent brick structures with integral fireboxes. Balls of amalgam were loaded in the retort and heated to volatilize the mercury. The metal left in the kettle, called the "sponge," was put into a crucible for smelting along with a flux that separated the gold from residual impurities (MacFarren 1910:121-124). Pittman (2008:31) remembered the amalgam balls being taken to the chlorination plant at Haile Gold Mine for chemical treatment. However, this is almost certainly a faulty memory. Pittman's own map of the site as it existed around the turn of the twentieth century illustrated a "Retort and Assay Shop" along with a "Smelter Works" that were separate from the chlorination plant.

CONCENTRATING

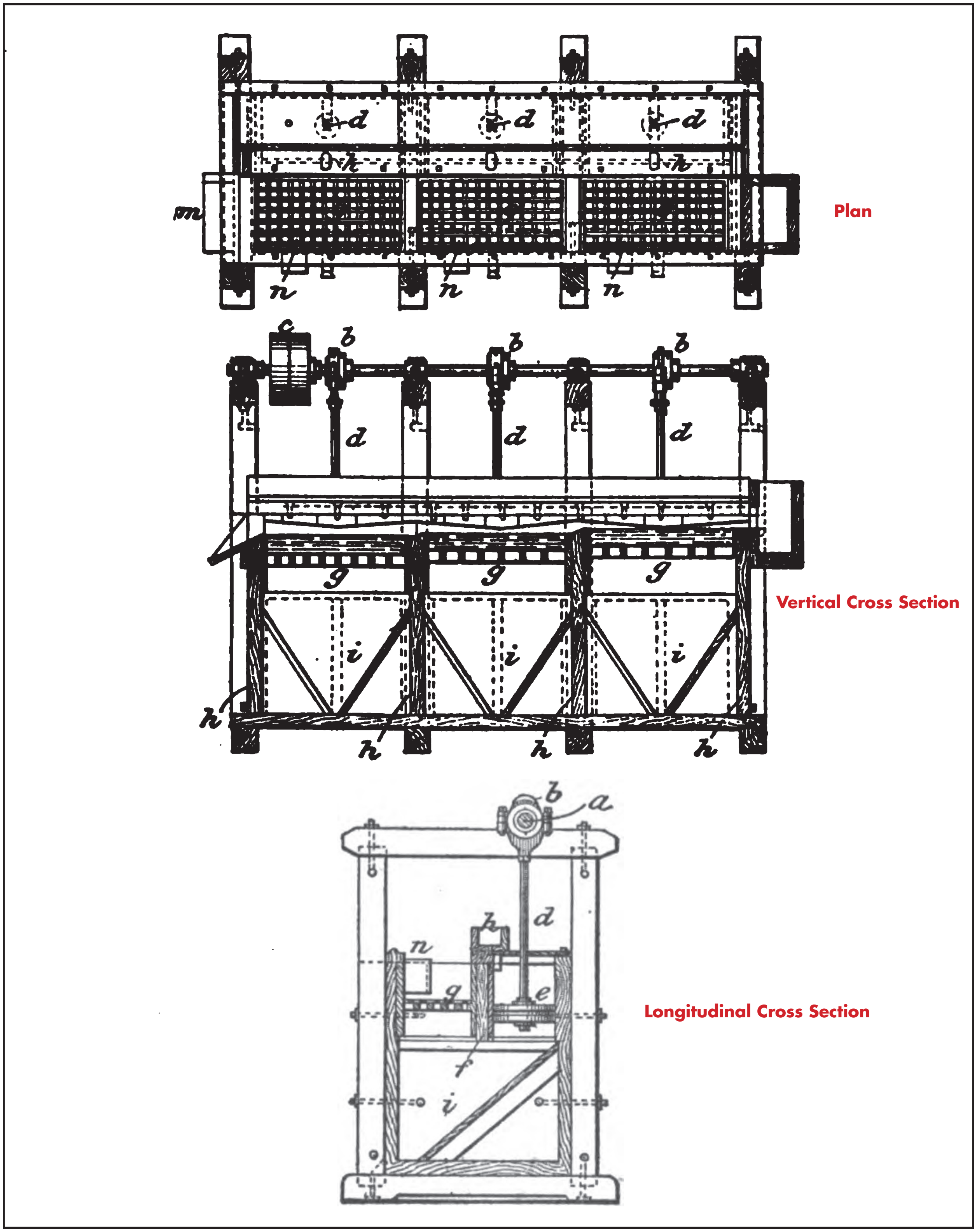
In some instances, and especially through much of the nineteenth century, amalgamation was the only process used to separate gold from gangue and the tailings from the process were discarded. Improvements in ore handling allowed extraction of gold from the amalgamation tailings. Part of the process involved increasing the proportion of valuable material in the tailings. The process called concentrating, or classification, yielded sulfides for further treatments.

Concentrating took advantage of the differences in specific gravity between two or more minerals. The mechanical methods of beneficiation described above technically fall under the heading of concentrating (Richards 1909). Machines used for the process, known as "concentrators," fell into two general categories. The first group used water currents to sort material into layers that could then be removed separately. Jigs were the main type of device in this category. The second category relied on the ability of heavier particles to cling to a surface against the force of a stream of water. This group included table and belt concentrators (International Library of Technology 1902:26.22). The type of machinery in use depended on the specific minerals involved, their individual properties, and the preliminary treatments that had already been completed.

Jigging involved sending intermittent water currents through a mixture of minerals to separate the ones with different specific gravities. The crushed minerals were placed in a box with a screened bottom and water was either pulsed through the mixture using a plunger or piston (Figure 17). Alternatively, the box was moved up and down to put the minerals in suspension. The minerals settled into layers that could be collected separately (Richards 1909:277; Hayward 1952:6).

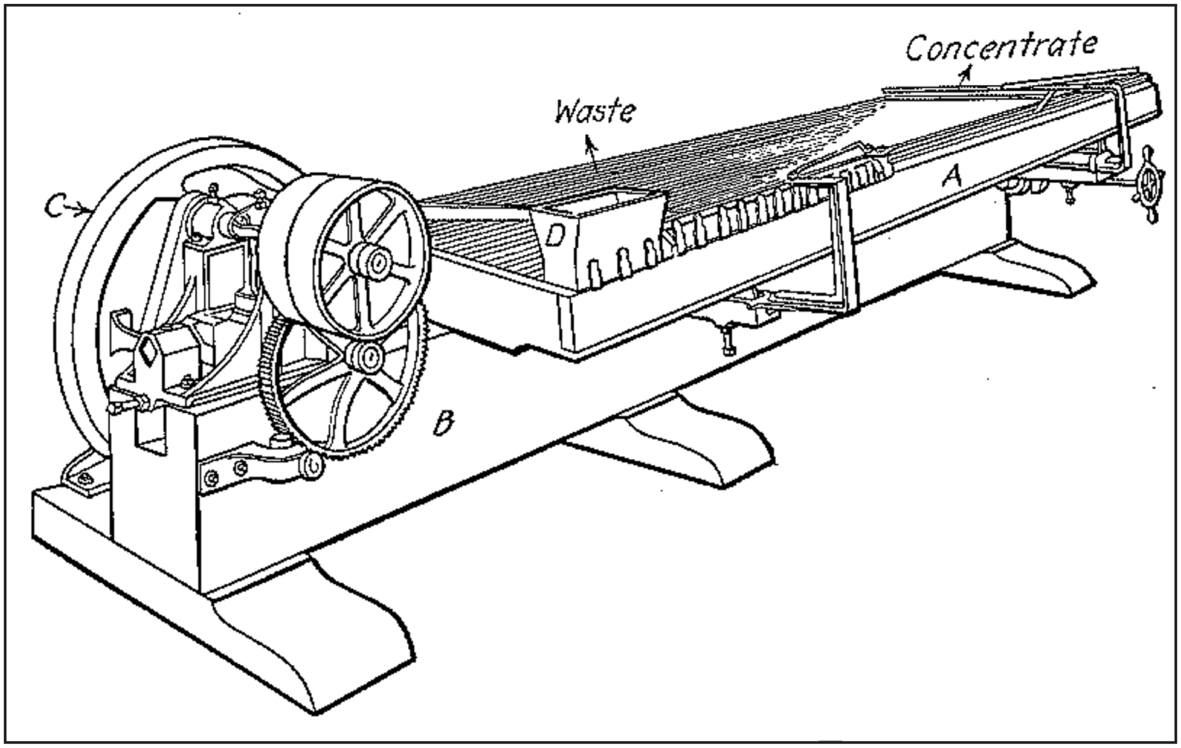
Other types of concentrators were known as "bump tables" or shaking tables (Figure 18A). These were a class of devices that essentially consisted of a rectangular surface covered with longitudinal shallow riffles that ended at a smooth cleaning surface at the discharge end. A mechanism oscillated- (or bumped-) the table, causing materials to move from the feeder to the opposite end. The table was also set at a slight angle on its long axis, the waste side being lower. Sands were fed continuously and worked along the long axis of the table while water was washed across the riffles and down slope. As the machinery oscillated the table with a series of short movements, the

Figure 17.
Jigs: Diagram of a Hartz Three-Compartment Jigger



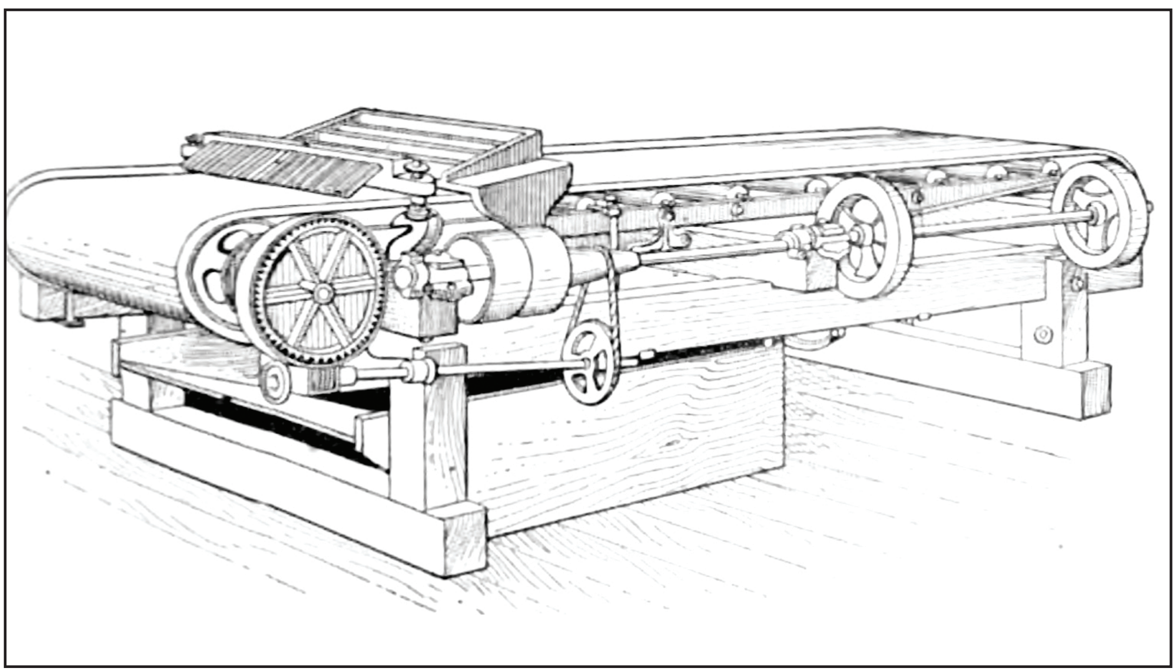
Source: Eissler 1900

Figure 18.
"Bump Tables" and "Vanners"



A. Wilfley Concentrating Table

Source: Hayward 1952



B. Frue Belt Concentrator Similar to the Embry Tables Used at Haile Gold Mine

Source: Louis 1902

heavy minerals settled into the riffles and moved to the opposite end of the table. The water washed the lighter materials across the riffles and off the low side (International Library of Technology 1909:27.2; Hayward 1952:7; Thrush 1968). The Wilfley Table was a common variety of bumping table and the Haile Gold Mine stamp mill used six of these at its most productive period.

The Haile stamp mill also used 20 Embrey Tables, which were a variety of belt concentrators or "vanners." A belt concentrator consisted of a rubber belt traveling up a slight inclination (Figure 18B). Ore separation took place as constant flow of water washed across the crushed ore while the belt was simultaneously shaken side to side to agitate the particles and keep them in suspension. Pulp was fed onto the lower end of the belt while wash water came in from the upper end to carry away the lighter materials. The heavier particles settled onto the belt and were dropped off at the upper end (International Library of Technology 1902:27.5-6; Richards 1909:350; Thrush 1968).

Depending on the mineral, concentrating could be an end process or the concentrates could be sent for further processing. At Haile Gold Mine, the concentrates went to the chlorination plant or, later, the cyanide plant to extract the gold.

HYDROMETALLURGY

Hydrometallurgy involved the treatment of ore, concentrates, and other metal-bearing materials by wet processes, usually involving conversion of one component to solution and its recovery from the solution (Thrush 1968). Two methods were used at Haile Gold Mine: chlorination and cyanide.

CHLORINATION

Considered obsolete by the mid-twentieth century, the chlorination process involved converting the gold to chloride, leaching it out with water, precipitating it, and then refining it (Hayward 1952:417). The process was developed in 1848 by Carl Frederick Plattner and introduced in California in 1857. The method was not used extensively in that state, but was common in the Appalachian goldfields (International Correspondence Schools 1902:34.1; Hardesty 1988:47-48, 2010:80). Technical advancements to the process included changing the containers in which chlorination took place and improving the preparation and introduction of the chlorine.

Roasting

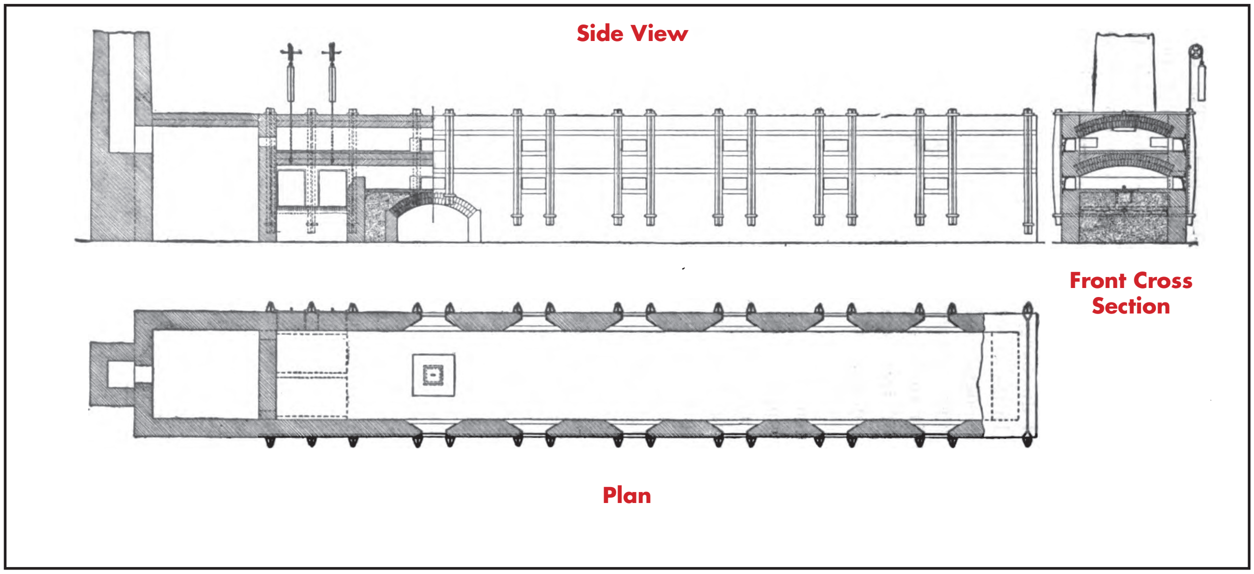
Before the ore went through chlorination, it was roasted. Although roasting could take place either in bulk as the ore came from the mines or after it went through processes of mechanical processing (Eissler 1900:258), insofar as it is known, Haile Gold Mine only roasted concentrates from the stamp mill. The purpose of roasting was to drive off sulfur, arsenic, and other volatile substances that were combined with the metals and to form metallic oxides, leaving only metallic gold that could combine with chlorine during the subsequent chemical treatment (Rose 1898:234). The process also changed the character of soluble salts such as ferrous sulfate or chloride so they would not act on the gold in solution (International Correspondence Schools 1902:34.4).

Roasting was accomplished in furnaces or reverberatories. The process began with a low heat that freed the sulfur of the sulfides and combined it with oxygen to produce volatile sulfuric acid. Known as an "oxidizing roast," this stage required the introduction of excessive air into the furnace as the ore was heated. As the metals in the ore lost part of their sulfur, they were converted into oxides and sulfates consisting predominantly of iron sulfates. Because these would precipitate the gold from a solution of chloride of gold, they required elimination by gradually increasing the roaster heat to decompose the sulfates and form oxides, a process called a "dead roast" (Wilson 1897:20-21; Eissler 1900:258-260; International Correspondence Schools 1902:34.4). For "chloridizing roasting," salt was added during the roast if certain substances, such as lime, magnesia, or lead, were present in the ore. The heat released chlorine from the salt. The free chlorine then combined with the metals to form metal chlorides that would not absorb chlorine during the subsequent treatment (Rose 1898:242; International Correspondence Schools 1902:34.4-5). In sum, roasting freed the gold so that the chlorination gas or solution could act on it most effectively and eliminated substances that would interfere with chlorination.

Various models of roasting furnace existed, with several being experimental models that never went into widespread use. The basic form of furnace was a reverberatory, called this because the roof of the hearth reflected heat back onto the surface of the ore charge. The key features of a reverberatory furnace were a shallow hearth, a low roof that gradually sloped downward from the firebox end to the stack end, and a raised wall (the "bridge") separating the flame from the ore that also directed the flame and heat toward the arched roof. Additional features included a hopper to load ore and apertures in the sides for spreading and stirring the ore (Wilson 1897:41-42; Rose 1898:235; Thrush 1968:920). Furnaces might also possess archways underneath the hearth that allowed ore cars to pass below and be loaded with the roasted ore. Construction of the furnace was brick, with firebricks used where necessary, and the entire structure was secured with iron bands to prevent expansion (Rose 1898:235; Eissler 1900:288). A tall chimney provided a draw. Wood was the preferred fuel because it did not contain sulfur and ash that might reach and contaminate the ore (Wilson 1897:41), although Rose (1898:235) indicated that length of burn was most important, with either long-flame coal or wood being acceptable as fuel.

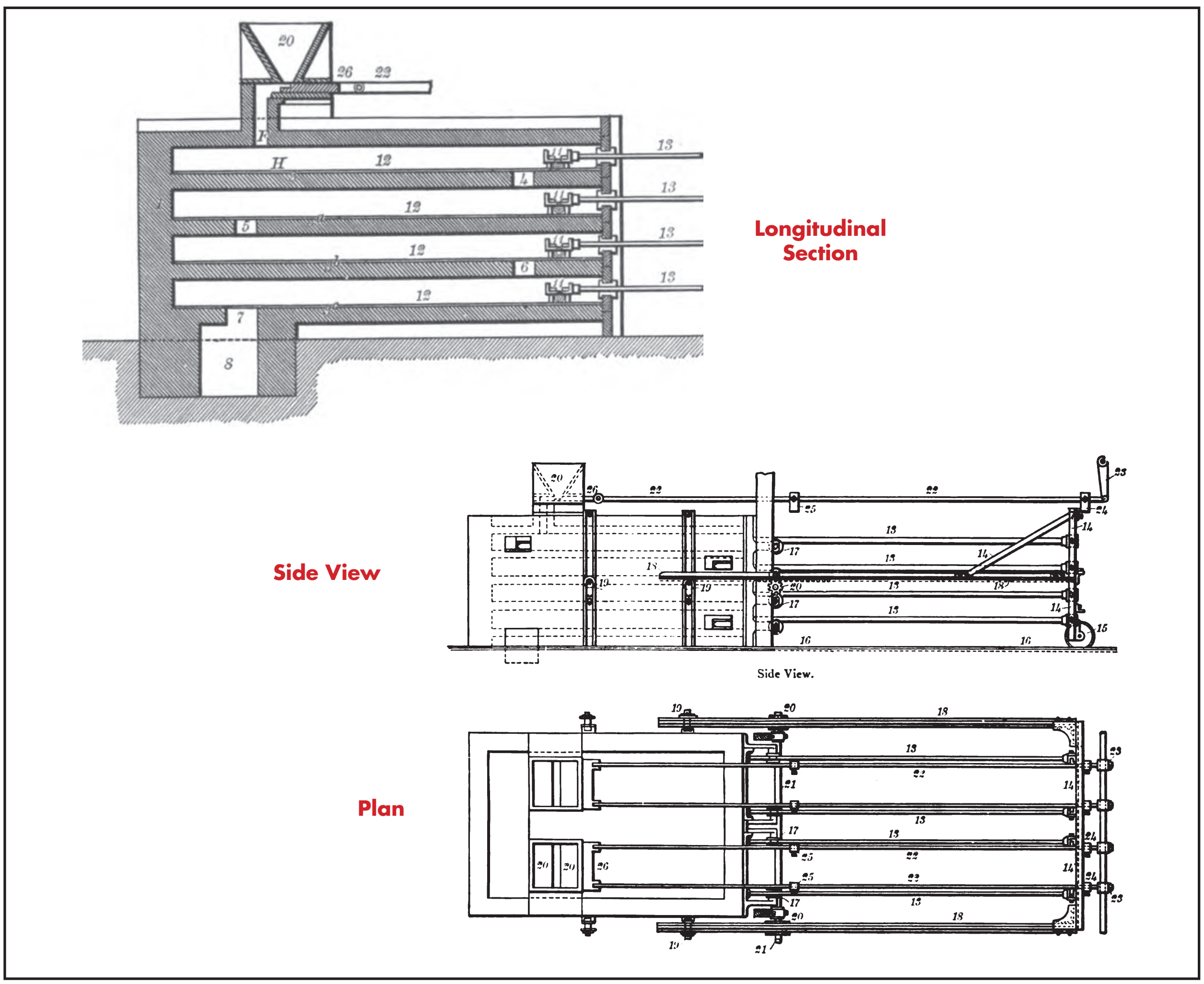
Among the variations of the basic single furnace was the double furnace, built with one hearth above the other with return flues that allowed heat to move from the first furnace up and back across the hearth of the second. Wilson (1897:43) noted that this type of structure was used to dry one charge of ore in the upper furnace, while another charge roasted in the lower furnace. Once the lower hearth was cleared, the dried ore above was dropped to the lower hearth. In a different process described by Eissler (1900:290), the ore in the upper hearth lost most of its sulfur, after which it was drawn to the lower hearth to finish roasting. A third hearth built above the first two was used for drying by drawing the heat across it before venting through the chimney. An illustration of the double-hearth furnaces used at Haile Gold Mine around the turn of the twentieth century indicated relatively long (40 ft.) structures with only two stacked hearths (Nitze and Wilkens 1897) (Figure 19A). This kind of roaster required hand rabbling (or stirring) the ore as it is roasted to expose various surfaces of the ore to the heat and keep it from fusing (Wilson 1897:24).

Figure 19.
Ore Roasting Furnaces Used at Haile Gold Mine



A. Double-Hearth Reverberatory

Source: Nitze and Wilkens 1897



B. Spence Furnace

Source: Eissler 1900

Additional types of mechanical furnaces were classified as stationary hearth furnaces with mechanically moving hoes for rabbling; rotating-bed furnaces with stationary hoes or stirrers; rotating cylindrical furnaces that tumbled the ore while it was roasted; and shaft furnaces arranged to have powdered ore fall in a shower through an ascending column of hot air (Rose 1898:247). Of these, the revolving pan furnace was used at Haile. Also called revolving hearth furnaces, these consisted of an iron pan that carried the ore to the heat. They were arranged to revolve horizontally and were equipped with fixed rabbles that continually stirred the ore, exposing fresh surfaces to the heat. The drawback of these devices was that they could not perform the dead roasting without a small reverberatory attached. The Haile furnace had a pan measuring 12 feet in diameter and eight inches deep with a 30-inch high dome above the pan. The attached reverberatory was 14x6 feet (Wilson 1897:46-47).

Haile also operated a Spence furnace, but with poor results. The Spence furnace was a type featuring a stationary hearth with mechanical rakes (Figure 19B). The furnace contained multiple stacked beds with openings that allowed ore to be distributed to each level. The rakes performed the work of mixing the ore and distributing it horizontally and vertically (Eissler 1900:300-304).

As roasting was completed, the ore was moved to a cooling floor. From here, it was elevated to the top of the chlorination plant (Nitze and Wilkens 1897; Wilson 1897:45).

Chlorination Procedure

The basic chlorination procedure entailed exposing roasted ore to chlorine gas and then leaching the ore in a water solution to produce gold chloride. Ferrous sulfate was added to the solution to precipitate the gold, which was then filtered out (Hardesty 2010:79). Initial techniques involved placing the ore in airtight, pitch-coated wooden vats and introducing chlorine gas that was produced in a separate process. The gas gradually permeated the ore and after several days, water was added to leach out the trichloride of gold. This solution was drained to precipitating tanks and converted to brown power by ferrous sulfate or later into hydrogen sulfide and charcoal. The precipitate was gathered, washed, and melted into gold ingots (Eissler 1900:345; International Correspondence Schools 1902:34.1).

Changes to the process included substituting revolving barrels for the vats, as in the Delacy process (patented 1864), which shortened the time required to chlorinate a charge of ore. Another modification was the Mears process (patented in 1877), which exchanged the wooden containers with lead-lined iron barrels and improved the gas-introduction apparatus by introducing it under pressure, which was thought to speed the rate of chlorination (Eissler 1900:382; International Correspondence Schools 1902:34.2).

Carl Thies developed important innovations to the chlorination process that he put into use at Haile Gold Mine. Thies' principal innovation was eliminating the production of chlorine gas outside the barrel, along with the equipment for pumping it under pressure into the ore barrel. Instead, the chlorine was created in the same barrel as the ore (International Correspondence Schools 1902:34.1-2). Thies also made changes to barrel size and the number of rotations to achieve optimal results (Rose 1898:302; Wilson 1897:99). By the time Thies was ready to install the chlorination process at Haile Gold Mine, he was using barrels with a capacity of 1-1.25 tons of roasted ore per batch (Minutes of Proceedings 1889:484).

Thies used a lead-lined iron barrel with a manhole for charging and discharging the ore. The barrel took a charge of 100-125 gallons of water and 1-1.25 tons of roasted ore. Ten to 15 pounds of chloride of lime were then added with 15-20 pounds of sulfuric acid. The barrel was rotated about six hours to dissolve the gold. Next, more water went into the barrel and spinning resumed to wash the ore and dissolve the gold chloride. The contents of the barrel were then poured out on shallow filter beds and precipitation was done as described above using protosulfate of iron (Thies and Phillips 1892:77-78; Eissler 1900:388-389). The precipitate was melted in Dixon crucibles with borax and soda as a flux, and cast into bars that were shipped to the United States Assay Office in Charlotte, where it was usually rated at a fineness of 975 to 985. Thies estimated his process obtained 94 percent of the assay value of the concentrates (auriferous sulfides), which was improvement on Plattner's original method (Thies and Phillips 1892).

Nitze and Wilkins (1897) described the chlorination plant at Haile as a four-story frame building containing three chlorination barrels, 11 filtering tanks, two storage tanks, and 13 precipitating vats. The ore was elevated 32 feet to the upper floor and deposited into cars holding one ton, which in turn charged the ore through hoppers into the chlorination barrels. From the barrel, the chlorinated ore went through a hole in the floor to filters on the next lowest level, and from these to storage tanks on the second floor. Solution was drawn from the stock tanks and put into precipitating tanks and settling tanks on the first floor (see Figure 9).

CYANIDE

Cyaniding is the process of treating ground gold and silver ores with a solution of sodium or potassium cyanide. The method was developed in the 1880s and began to replace older methods soon afterwards. The first American cyanide mills were built in 1891 and used for gold. The method was not applied to silver ores until after 1900 (Hardesty 1988:51, 2010:84). At Haile Gold Mine, the cyanide process was introduced only after the boiler explosion led to the closure of the chlorination plant and a hiatus in mining operations. In 1911, the Haile Gold Mining Corporation built a small cyanide plant to work the tailings of the earlier operations, but this plant only operated for a few years. A larger plant opened in the 1930s that ran until World War II.

The cyanide process could vary in specific steps and procedures depending on the nature of the ore and materials, but there were three principal stages to the process: dissolving, precipitation, and smelting (Hayward 1952:437; Thrush 1968; Hardesty 1988:51). Roasting was not usually required except to remove an element that prevented or hindered the gold's solution in cyanide (Clennell 1910:286). Cyaniding worked best on fine concentrates because small particles dissolved fastest (Eissler 1900:485).

Clennell (1910) described the process as it was generally practiced. Typically, sands and slimes were treated separately with different techniques. Sands went through percolation methods and slimes through agitation. Some plants, such as Haile in the 1930s, only processed very fine concentrates using the "all sliming method," which involved finely pulverizing the ore (Hayward 1952:437-438). By 1910, "all slime" plants achieved the desired texture with ball and tube or rod mills (Hardesty 1988:41; 2010:69). The detailed descriptions provided below indicate the processes along with equipment and materials.

Cyaniding was applied to the tailings of amalgamation, which removed the coarser gold particles. Wilfley tables or other concentrators separated and enriched the gold-bearing ores before further treatment. The amalgamation tailings then went through a hydraulic separation process in a device known as a "spitzlutte," which used water jets to separate the slimes and sands. Sand then went through percolation to ready it for cyaniding. Percolation involved distributing the sand in a collecting vat that was continually flushed with water to float off residual slimes. The sand might be treated with lime at this point to reduce acidity. Once ready, the sand went to a filter or leaching tank where dissolving took place. This stage required a series of washes, typically including one to two baths in a weak cyanide solution, one in a strong solution, and several more in increasingly weaker solutions. Finally, a water wash completed the process. The solution was drawn off from the bottom of the tank so that the filter, a mat of coconut fiber and canvas, ensured the clarity of the liquid. Sometimes additional settling was required to make certain that the liquid sent to the precipitation boxes was clear (Clennell 1910:33ff; Hardesty 2010:88).

To this point, slimes were handled differently. Once separated from the sand, the slimes went to a spitzlutte or other vessel to remove superfluous water. Lime was added to help the slimes coagulate and settle. An alternative method for concentrating the slime was to process it on concentration belts before sending it to collection tanks for settling. The dissolving stage took place in agitation tanks where mechanical stirrers or pressurized air injections suspended the tailings long enough to be dissolved. The slimes might go through additional processes including decantation, during which additional settling and agitation took place before the water and moist residue were separated, or filter presses, in which compressed air or vacuums separated the liquid from the solid residue. The important point in treating the slimes was to ensure that the liquid sent to the precipitation boxes was as clear as possible (Clennell 1910; Hardesty 2010:89-90).

The solution from the sands and slimes went through the same processes of precipitation and smelting. Precipitation took place in zinc boxes, consisting of trough-like containers with internal dividers that allowed the solution to flow under and over them as successive boxes were filled. Zinc shavings were added to the solution to precipitate the gold. At this point, a metallic deposit formed on the zinc, which if done properly would be brownish black and would be most prevalent in the first compartment of the zinc box but decrease thereafter. The gold precipitate was collected and put through an additional acid treatment to convert the zinc to water-soluble zinc sulfide and eliminate other impurities that could be washed out. This process was sometimes aided by stirring or heating, or the precipitate was roasted instead of being subjected to acid treatment. The final step in the process was smelting. The precipitate was mixed with a flux and sometimes an oxidizer, heated in crucibles or reverberatories, and the bullion cast into molds (International Library of Technology 1902:32:11; Clennell 1910).

PYRITE MINING

During World War I, mining at Haile Gold Mine was reoriented toward pyrite production for use in the manufacture of sulfuric acid. Like many other minerals, efforts to increase production accelerated during the war to offset increased consumption and declining imports (SC Department of Agriculture, Commerce and Immigration 1908:121; Watkins 1918:517; Manning 1919:48).

Although the property was leased for pyrite production in 1915, the first operations began in 1918 after the Kershaw Mining Company took over the property (Thompson 1919:45). Production dwindled after the war, possibly as a result of decreased demand and the availability of cheap Latin American sources (Botwick et al. 2011:43).

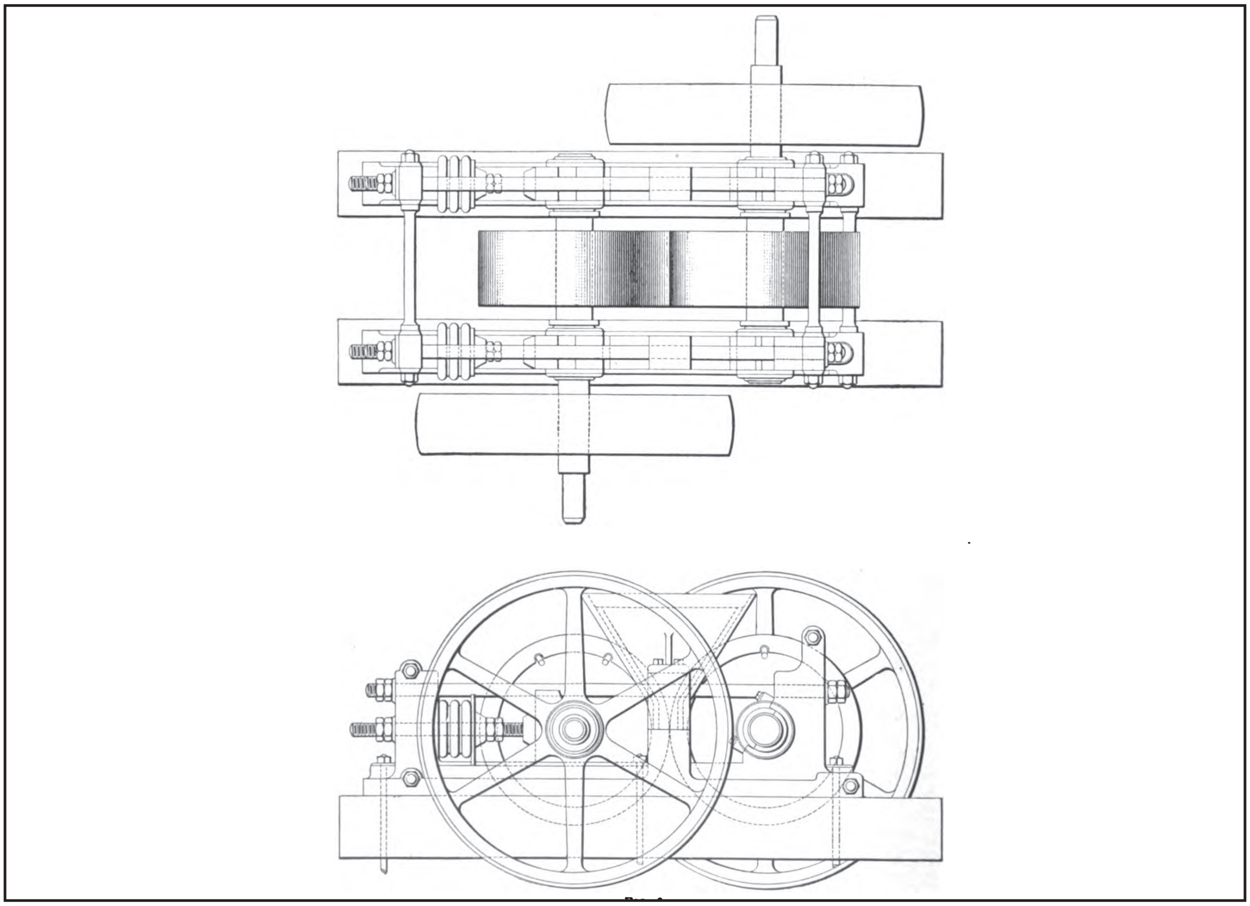
Commercial manufacture of sulfuric acid required converting sulfur dioxide to sulfur trioxide and uniting it with water to form the acid. The procedure required first burning pyrites or other metallic sulfides to generate sulfur dioxide. The reactions involved in manufacturing the acid took place during either the chamber process, or the contact process. Briefly, the chamber process essentially involved combining sulfur dioxide, oxygen, and water in the presence of oxides of nitrogen. The reactions that occurred between these substances produced sulfuric acid. The contact process entailed heating gaseous sulfur dioxide and oxygen together in intimate contact with a catalytic material, which caused a complete and rapid oxidation of sulfur dioxide to sulfur trioxide. Cooling the vapor formed during the reaction and absorbing it in strong acid yielded the desired product (Wells and Fogg 1920). There is no evidence that sulfuric acid was made at Haile Gold Mine, and a recent study of pyrite mining in Georgia suggested that pyrite mining and acid manufacture were separate activities that were not spatially related (Botwick et al. 2011:93). The Kershaw Mining Company was involved only in the production of pyrite ore, which was then sent to plants in Virginia and Alabama (Schrader 1921:332).

Pyrite went through a process of beneficiation that yielded concentrates for shipping. Watkins (1918:520-521) described the activities of the Kershaw Mining Company after it took over Haile. Gear and materials left from the gold mining operation included boilers, engines, hoists, compressors, stamp batteries, crushers, and tables, about one mile of light rail, one small saddle-tank locomotive, a number of ore cars, a machine shop, and several houses. Watkins noted that much of the equipment was obsolete, but some was being used. Respecting the stamp mill (Site 38LA383), it was remodeled to produce pyrite concentrates, the stamps being replaced with jigs, rolls, and crushers (Watkins 1918; Schrader 1921:333) (Figure 20).

Pyrite operations at Haile involved excavation in underground mines, and putting the ore through a series of crushers and rollers to break it free from the gangue. General methods for classifying pyrite ore included hand picking, grizzlies, and trommels, while jigs and Wilfley tables concentrated it (Figure 21). Once the pyrite was separated from the schist gangue at Haile, it was placed in tanks to settle and concentrated on Wilfley tables to increase the proportion of sulfur content to about 47 percent (Watkins 1918:520; Ladoo 1925:469).

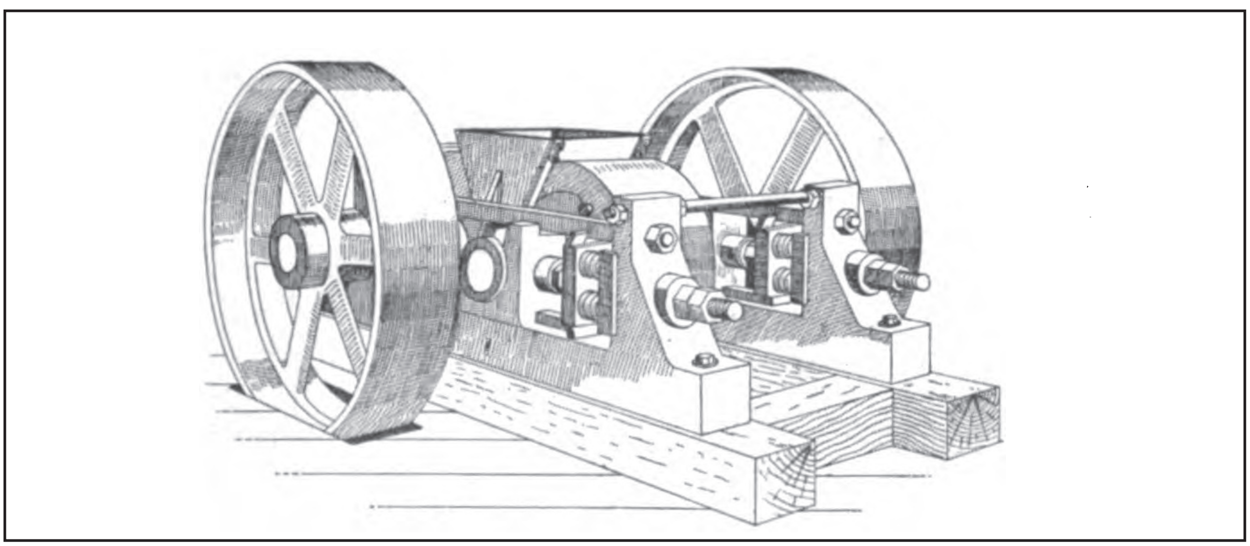
Pyrite was produced in three grades: "lump," consisting of pieces less than 18 inches and having all the fines screened out; "furnace," measuring between 2.5 and 0.25 inches; and fines, which were less than 0.25 inches. Southern producers mostly turned out fine ore and concentrates (Wells and Fogg 1920:38, 44), but Haile produced lump ore (Wells and Fogg 1920:45; Schrader 1921:332).

Figure 20.
Belt-Driven Roll Crusher Type Commonly Used at Pyrite Plants



A. Plan and Side Views

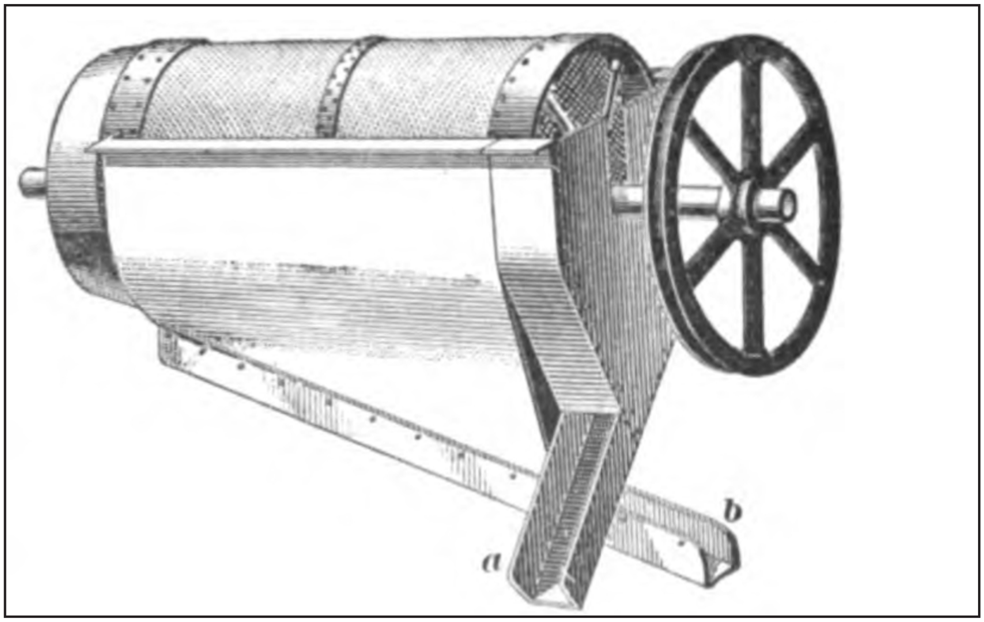
International Library of Technology 1902



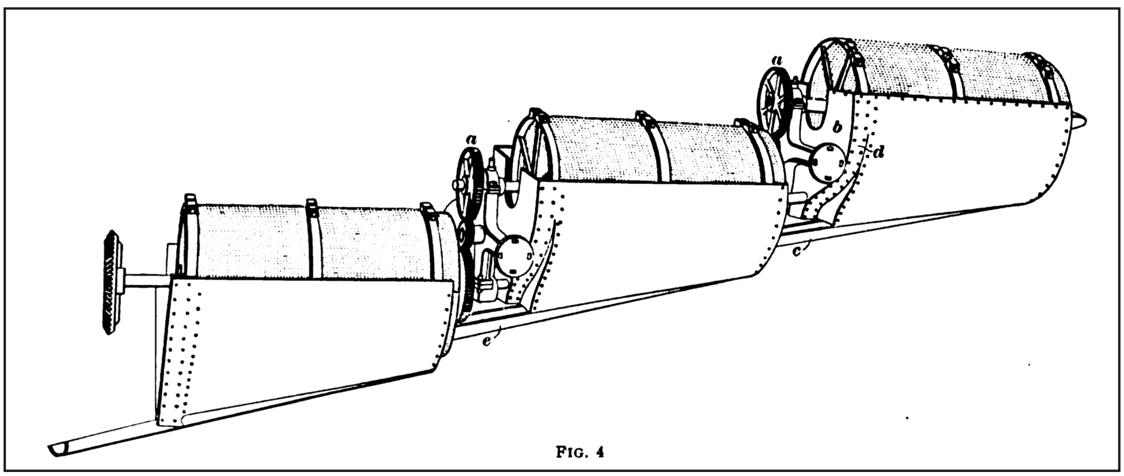
B. Oblique View

Source: Hofman 1913

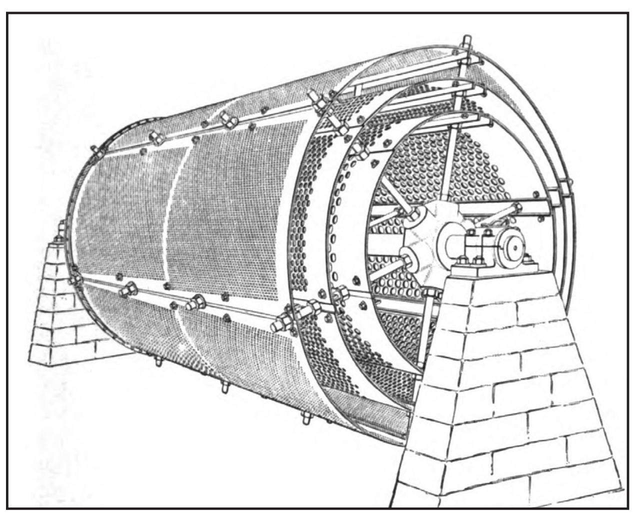
Figure 21.
Trommels for Sizing Ore



A. Drum Screen



B. Multiple Drum Screens Arranged to Sort Ore into Successively Smaller Sizes



C. Screens Arranged in Concentric Drums to Sort by Size

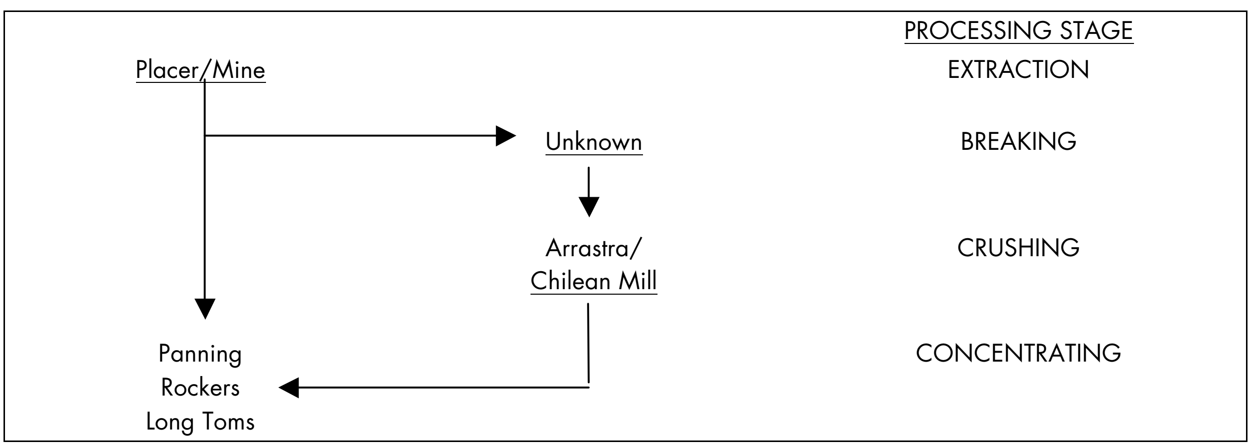
Source: International Library of Technology 1902

HAILE GOLD MINE

Over the course of its nineteenth to early twentieth-century operation, Haile Gold Mine went through a relatively typical progression, while also being the site of some unique innovations in gold mining technology. The following flow sheets summarize how the various extraction methods described above were employed at Haile at different times. These diagrams illustrate the role of the stamp mill (Site 38LA383) in the mine's operations, as well as how mining proceeded in the period before the mill was built.

The earliest development of the mine in the late 1820s took advantage of the more readily accessible free gold in placer deposits. Somewhat later, Benjamin Haile leased plots to mine gold from the local schist beds. Tools and methods at this time included Chilean mills or arrastras, and long toms or other sluicing equipment. These were traditional devices commonly used at simple or small-scale gold mining operations. There is little detailed information available on how mining was conducted at Haile during its earliest period, but it is likely that the first miners did not use methods more elaborate than necessary to collect free gold. The process probably involved separating gold from waste through the traditional methods of panning or with devices such as rockers, sluices, and long toms. For gold not already loose from natural weathering, an additional step of crushing the ore in arrastras and Chilean mills was necessary (Figure 22).

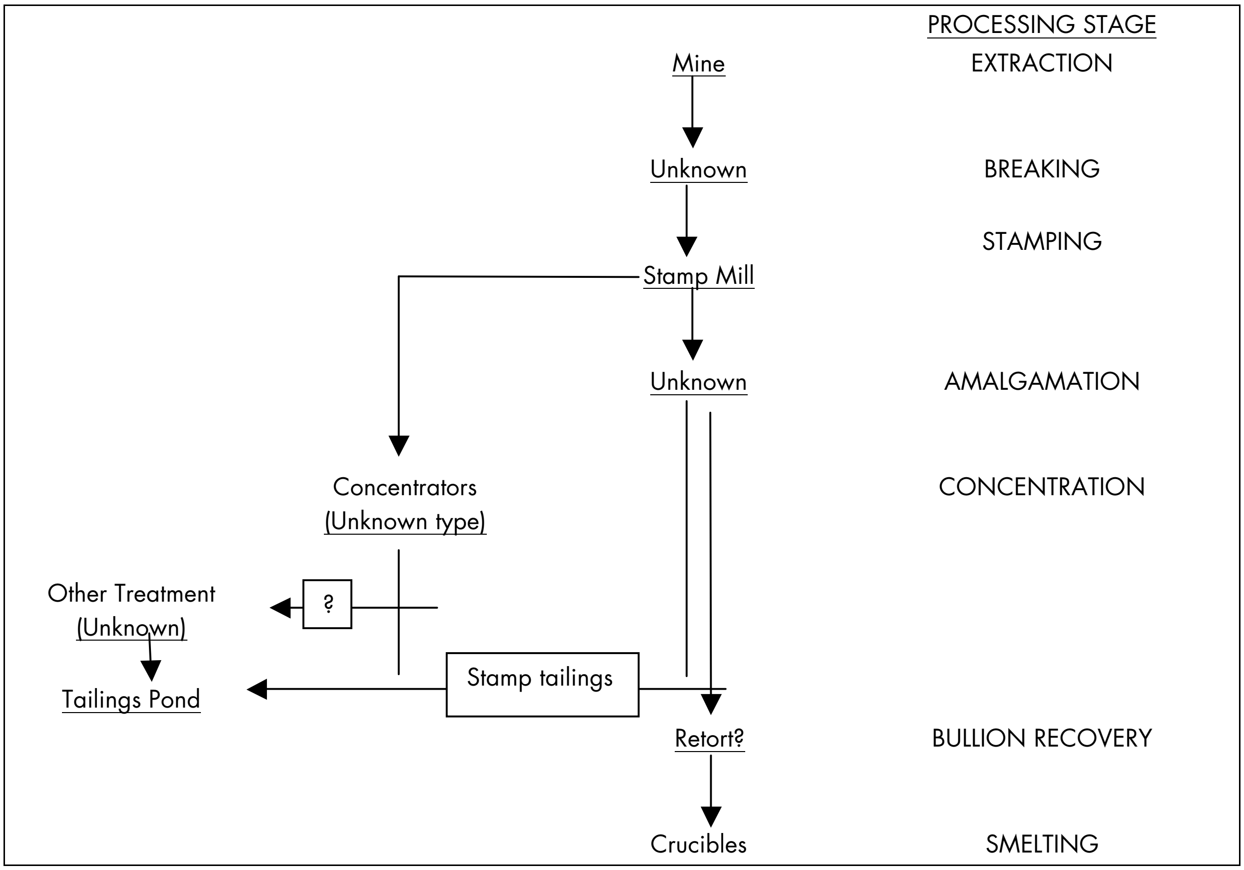
Figure 22. Haile Gold Mine Flow Sheet, Circa1827-1860



The procedure used at Haile to break the ore for arrastras and Chilean mills is not known, although the first stamp mill might have been used for this purpose after 1837, as was often the case in western gold mines. However, stamp mills generally supplanted arrastras and Chilean mills and reflected more industrialized operations. They were more likely to be viewed as improvements over the arrastra rather than as supporting equipment (Van Bueren 2004:9, 11). No information on the operation of the early stamp mill at Haile was found and it is unknown if or how it was combined with other the arrastra operation. It is possible that the stamp mill was used in a similar way to the technique used in the early California goldfields. In that region, miners used stamps only to break apart gold-bearing rock. The freed gold was then collected with sluices or other means and no further processing was conducted (Quivik 2003:8).

After the Civil War, Phineas Tompkins put a considerable amount of money toward reopening Haile Gold Mine. Archival sources suggest he used amalgamation in conjunction with a small stamp battery. He also built a water mill to power the stamps. Little information was found on the actual process Tompkins used, but the 1870 U.S. Census indicted the equipment on hand and from that the basic flow through the process can be sketched (Figure 23).

Figure 23. Haile Gold Mine Flow Sheet, Circa 1866-1880

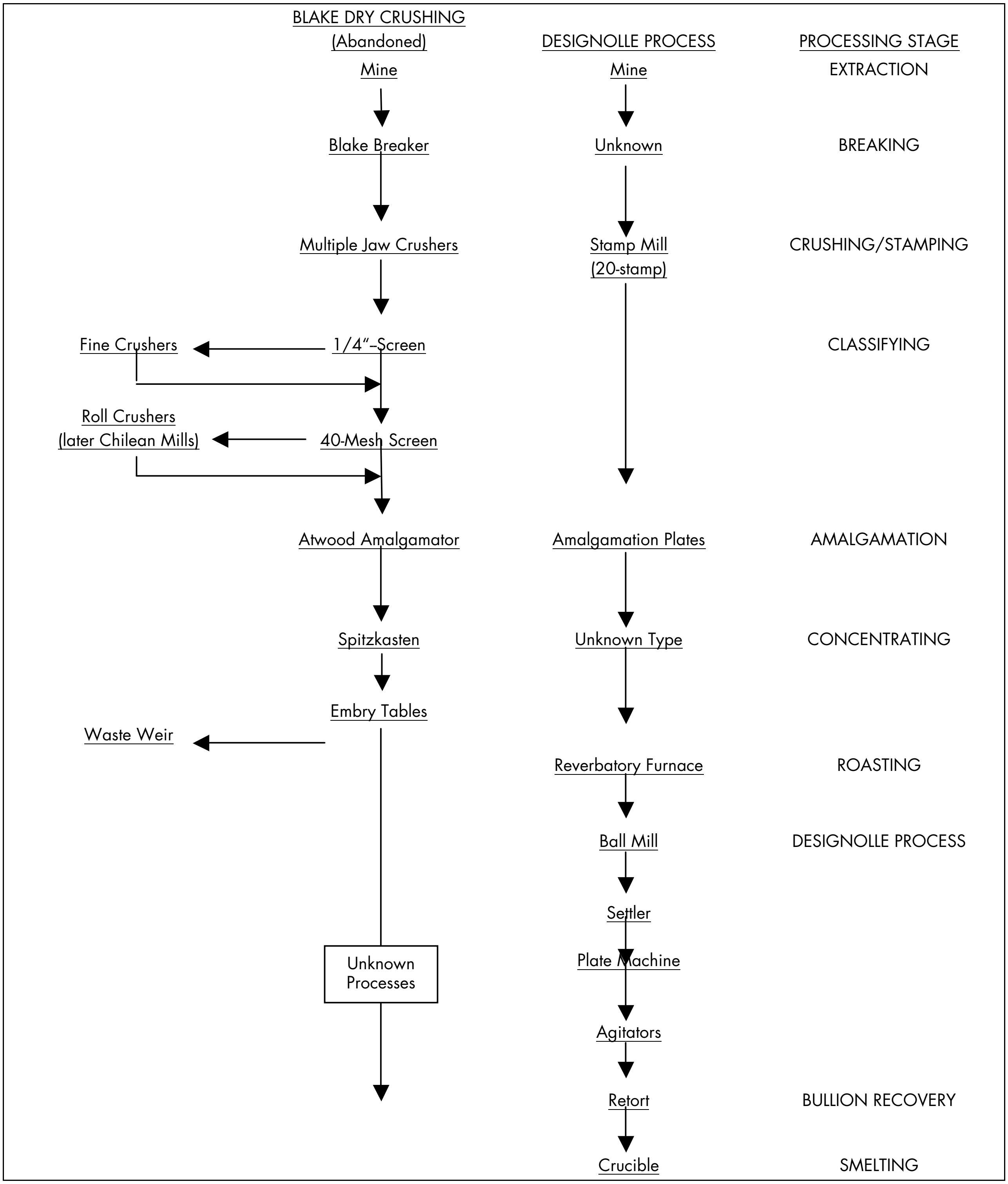


Gybbon Spilsbury took over Haile Gold Mine in 1880 and implemented several improvements for extracting gold from sulfides. He also experimented with newly developed equipment and systems. For a short time, for instance, Spilsbury tried the Blake System, developed in the 1880s, for producing finely crushed ores (Blake 1888; Nitze and Wilkens 1897). Later, he turned to the Designolle process, which used a solution of mercuric chloride to improve the recovery of gold from concentrates after stamping.

The Blake Fine Crushing process developed by Theodore Blake used various types of jaw crushers and screens to reduce the size of the ore and classify it for amalgamation. As Blake (1888) described the process used at Haile Gold Mine, the ore was first broken down in a Blake Breaker and then passed on to crushers with multiple jaws. From here, the ore was classified to size, with oversize pieces being diverted to rolling crushers or, later, Chilean mills. The pulp then went to

Atwood amalgamators, which suspended the pulp while the gold particles sank to copper plates at the base. Lighter concentrates containing gold were further treated with different concentrating equipment (Figure 24).

Figure 24. Haile Gold Mine Flow Sheet, 1880-1888–Spilsbury Manager



The principle of the Designolle process was that mercury was reduced during the operation by the action of metallic iron on a solution of mercuric chloride, making it amalgamate more actively than if it were added as metal initially. The process involved roasting the concentrates coming from the stamp mill and then putting them in a revolving iron barrel along with iron balls and a mercuric chloride solution. The iron first precipitated the gold from their chlorides and freed the mercury from the mercuric chloride, allowing it to amalgamate with the gold. Mercury was then added to the pulp to bond with the separated amalgam particles. From the barrel, the solution went to a settler containing copper plates that caught the amalgam. The solution was further treated in a metal cylinder containing stacked copper plates and then agitators (Rose 1898:136; Schnabel 1898:702) (see Figure 23). Spilsbury seems to have settled on this process by the mid-1880s (Spilsbury 1884:104-105).

During the last stage of the Gold Mining operation before the twentieth century, Carl Thies took over management of the operation and implemented additional expansion and modifications. Thies' chief contributions were to enlarge the stamp mill and institute the chlorination process for treating the concentrated ore. It is unclear how or if buildings and equipment left from Spilsbury's tenure were used, although it seems clear that the stamp mill, roasting house, and concentrating operations were in the same place. Insofar as details on the process are known, Thies' (Thies and Phillips 1892) method for extracting gold through chlorination is illustrated in Figure 25.

Finally, the World War I-era pyrite operation used the former gold stamp mill after renovations. Reportedly, the stamp batteries were taken out and replaced with crushing and concentrating equipment. Particulars regarding the types and numbers of devices were not found, but the basic flow of ore can be illustrated (Figure 26).

The present archaeological study focused on remains of the stamp mill that was built by Spilsbury, if not earlier when Tompkins operated the mine, and which was expanded and rehabilitated in later years. Reference to the preceding summary and figures indicates the flow of ore from the mine to finished product and shows the position of Site 38LA383 in this process at different periods in Haile Gold Mine's history.

Figure 25. Haile Gold Mine Flow Sheet 1888-1908–Thies Manager

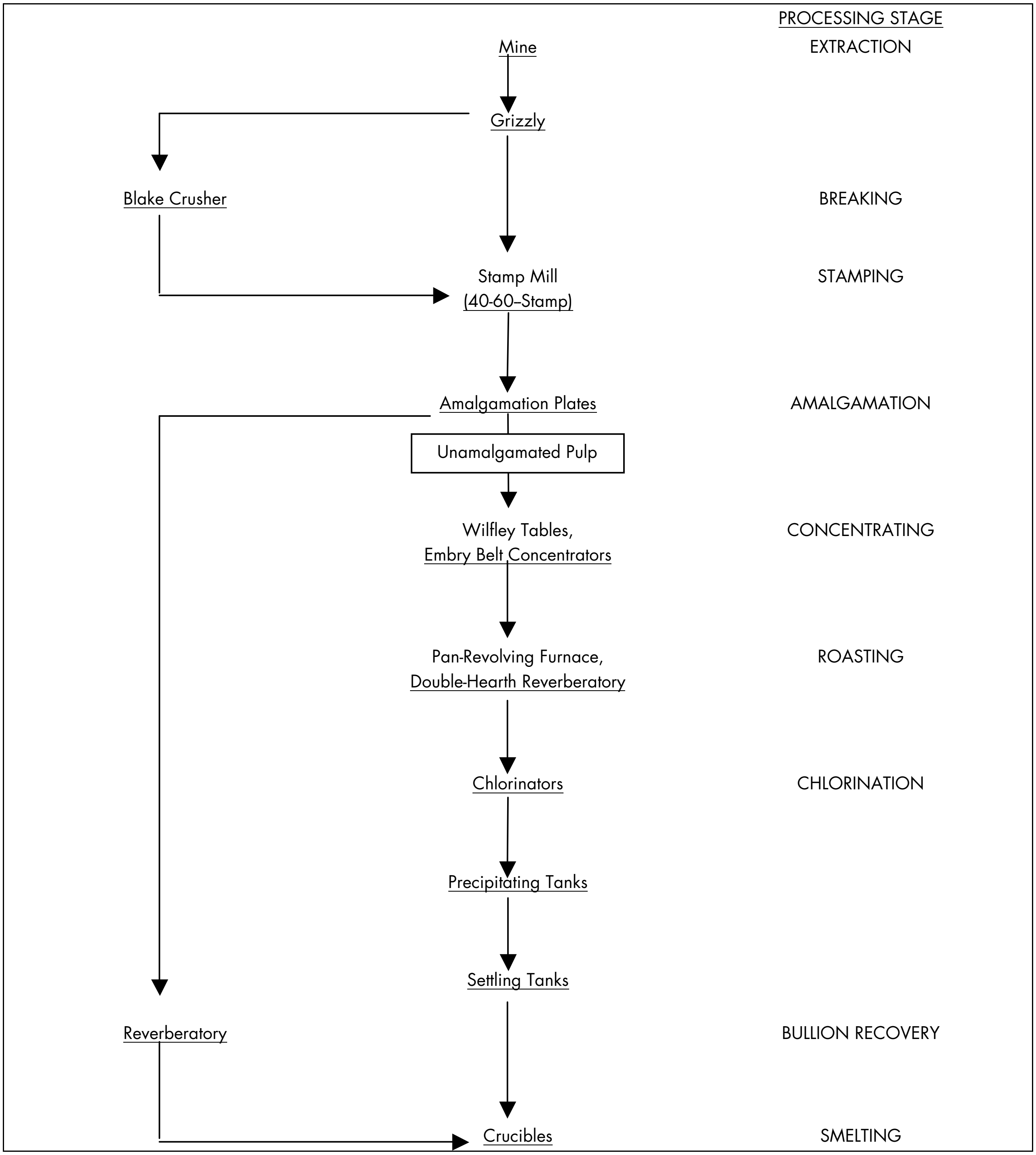
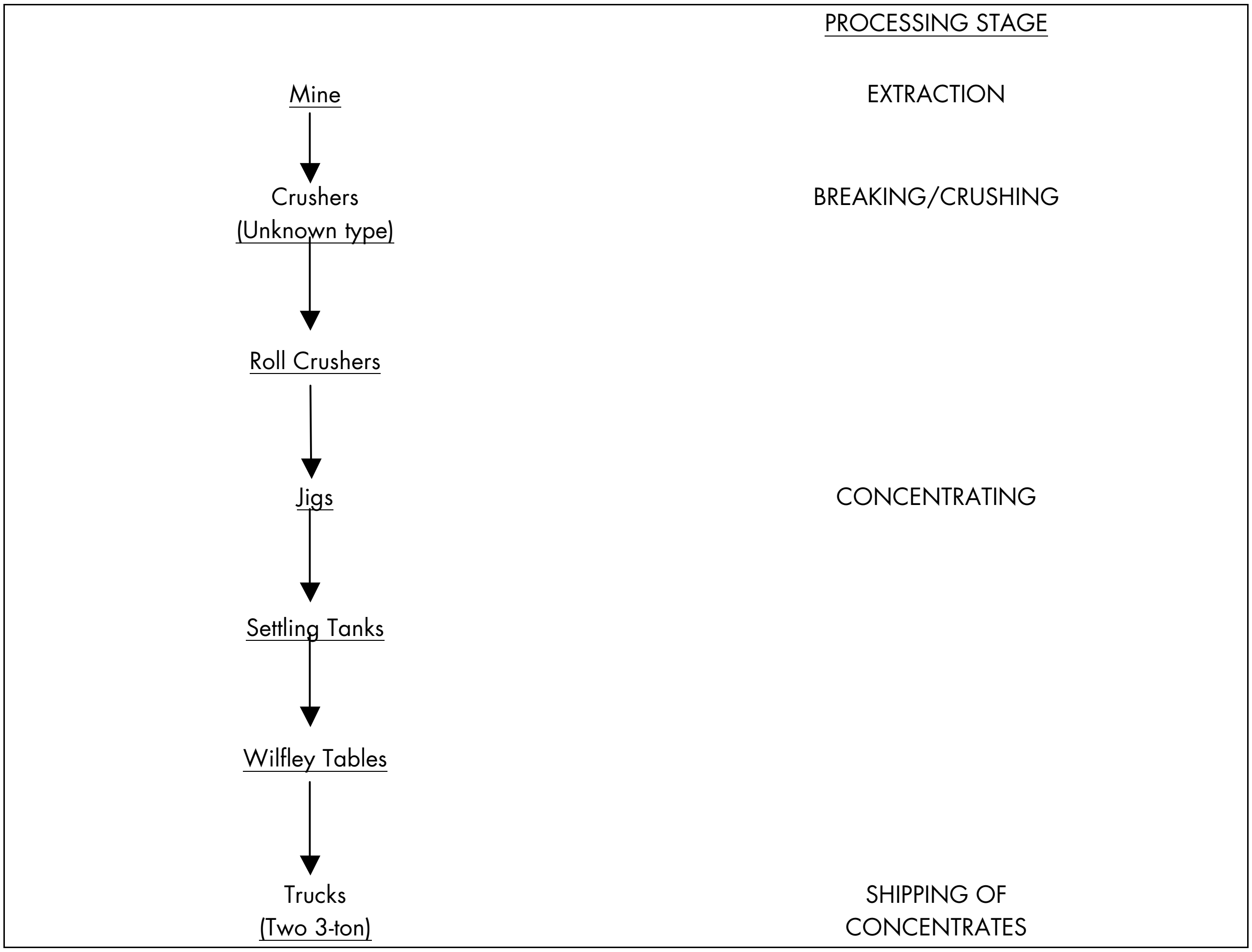


Figure 26. Kershaw Mining Company Pyrite Processing Flow Sheet



V. ARCHAEOLOGY OF THE HAILE GOLD MINE STAMP MILL

Site 38LA383 represents remains of the Haile Gold Mine Stamp Mill/Kershaw Mining Company Pyrite Mill with related and nearby structures and features. Archaeological investigations of this site involved detailed documentation and mapping to partly mitigate the effects of planned modern gold mining. The archaeological fieldwork at 38LA383 took place between April 25 and May 5, 2011, with analysis following immediately afterwards. This work resulted in the identification of 22 cultural features and the preparation of a detailed map of the site showing its relationship to the landscape (Figure 27). Two backhoe trenches were also excavated to investigate selected features.

SITE DESCRIPTION

The site occupied terraces and ridge flanks on the east side of Haile Gold Mine Creek. The landforms included relatively level ridge crests in the eastern part of the site, moderate to excessive slopes facing west, and a stream terrace in the site's west portions. From east to west, the site encompassed approximately a 15-meter (50-ft.) drop in elevation across a distance of approximately 100 meters (300 ft.). Vegetation was forest and consisted of mixed pines and hardwoods, with most trees estimated at less than 30 years old. The understory was light to moderately dense shrubs and ground cover consisted of thick leaf and pine needle litter making visibility poor.

Although several structural features were extant at the site, there was also evidence of post-occupation disturbance. Notably, a paved and embanked segment of Haile Gold Mine Road that was abandoned when the road shifted south covered the south portion of the site and partly buried Feature 5, a brick structure and debris pile. In addition, the creek terrace was generally flat and erosion control structures (e.g., rip rap, silt fence) had been placed here, suggesting past earthmoving here. Finally, push piles, spoil dumps, and debris were noted on the ridge flank and crest, indicating some post-occupation clearing or grading.

FEATURE DESCRIPTIONS AND INTERPRETATIONS

Fieldwork resulted in the identification of 22 features (Table 2). Several of these reflected the stamp mill and associated structures, while others related to gold or pyrite mining activities, such as transporting and processing ore. Additional features could not be clearly related to known activities or functions at the site. The fieldwork for this project allowed for few of the features to be inspected in detail. In most instances, hand clearing and visual inspection comprised the extent of feature analysis. Detailed feature descriptions and interpretations are provided below. Feature descriptions are grouped according to their associations to provide a context for interpretation (Table 3).

Figure 27.
Plan of Site 38LA383

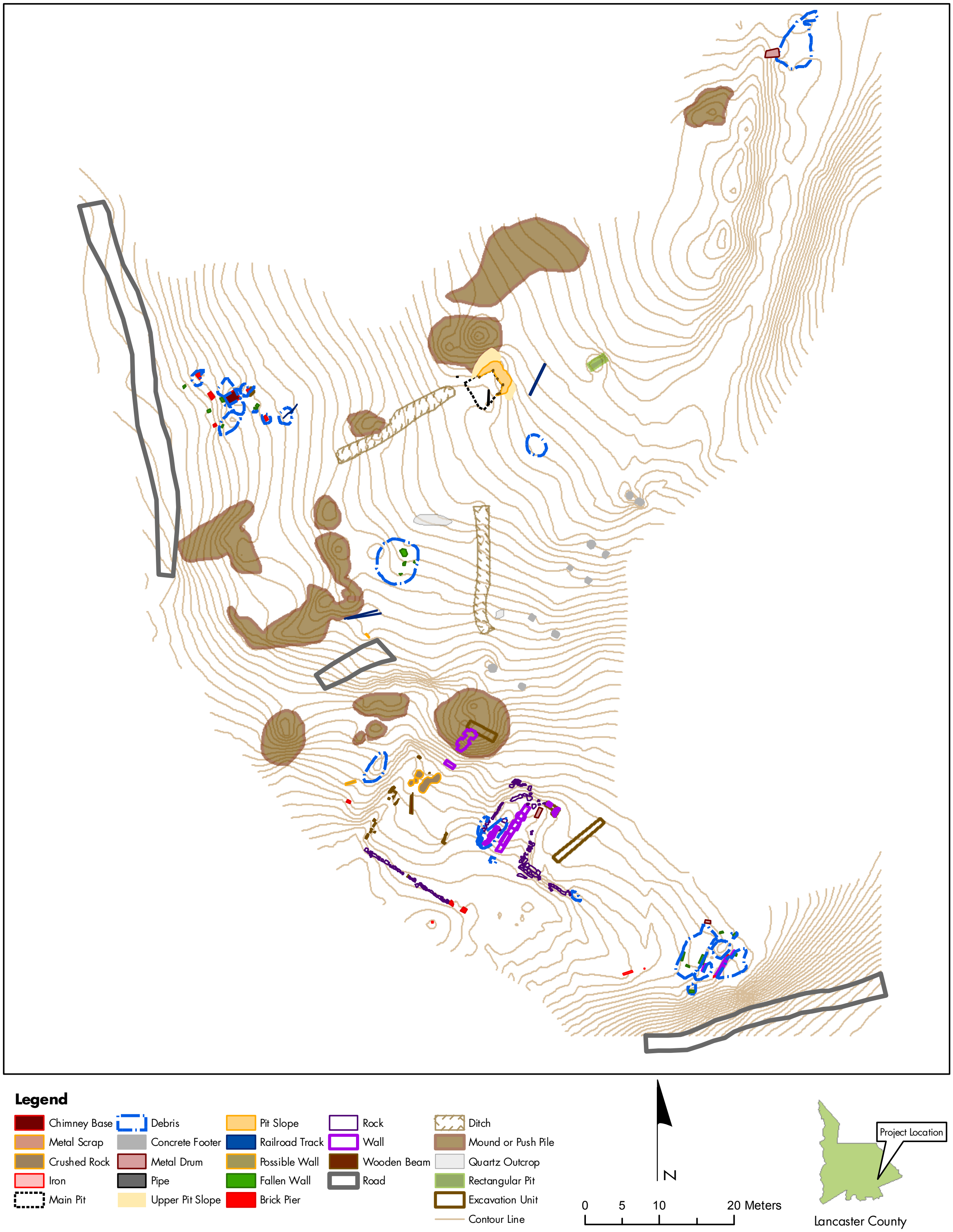


Table 2. Site 38LA383 Feature Inventory

Feature	Description	Interpretation
1	Masonry machine mounts/building foundation	Steam engine mount for Stamp Mill
2	Stone wall	Foundation or retaining wall for steam plant
3	Brick pier	Part of Stamp Mill foundation
4	Iron Hardware (loose)	Gear shaft or rod
5	Brick wall segment with rubble	Indeterminate structure
6	Iron bar/wire	Refuse deposit–indeterminate association
7	Masonry/cement walls and mound	Stamp Mill structural component
8	Square cut in slope	Possible building corner
9	Brick rubble	Indeterminate rubble deposit
10	Square pit with iron pipe	Possible reservoir
11	Railroad rail	Loose single rail
12	Rectangular pit	Indeterminate
13	Massive trench/cut through ridge	Mine railroad cut
14	Group of 10 cement footings	Mine railroad, elevated segment
15	Group of brick piers, chimney base	House or office
16	Wood beams/structure	Stamp Mill/battery footing
17	Wood beams/structure; crushed rock	Stamp Mill/battery footing; tailings
18	Rock and brick alignment/wall	Stamp Mill wall foundation
19	Cement bag/refuse dump	Refuse dump–indeterminate association
20	Railroad rails	Loose rails (pair)
21	Brick pier	Indeterminate footing associated with Stamp Mill
22	Rock pile	Unmodified rock dump next to Stamp Mill

Table 3. Feature Groups

Feature Group	Associated Features
Stamp Mill	1, 2, 3, 4, 7, 8, 16, 17, 18, 21
Features Associated with the Stamp Mill	10, 11, 13, 14, 20
Non-Mining or Indeterminate Features	5, 6, 9, 12, 19, 15, 22

STAMP MILL

Features that can be definitely or tentatively associated with the stamp mill/pyrite mill, related structures, and equipment include Features 1, 2, 3, 4, 7, 8, 16, 17, and 18. Feature 21 is also probably associated with the structure (Figure 28).

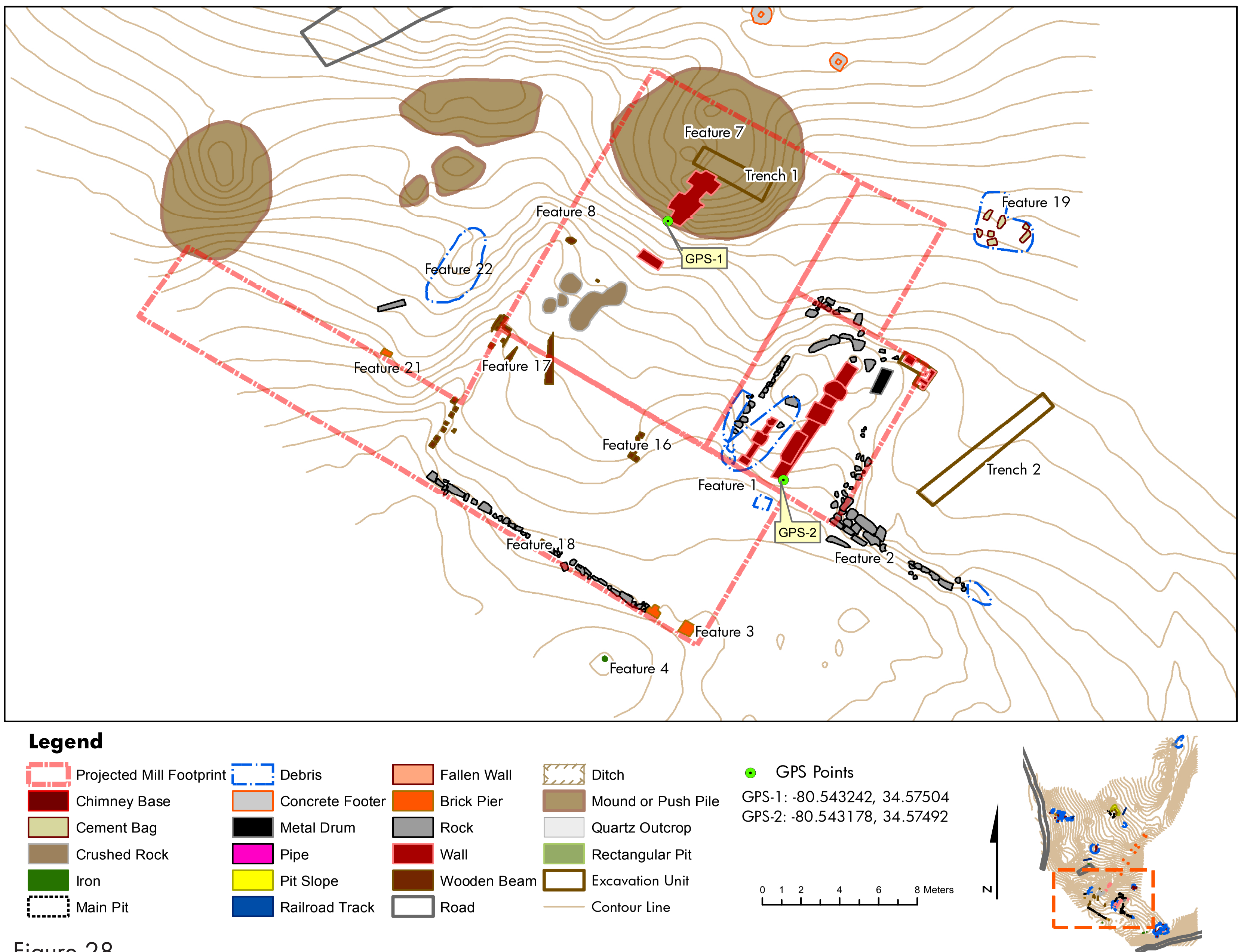


Figure 28.
Site 38LA383 Plan Section Showing Features Reflecting the Stamp Mill and Adjacent Area

Feature 1

Feature 1 reflected the mill's engine room. The feature encompassed a group of masonry structures, including two parallel walls of brick, cement, and granite, and a stone and brick building foundation that enclosed the masonry wall on three sides (see Figures 28 and 29).

The two parallel masonry walls represent the footings for the engine and flywheel. They had roughly similar construction techniques but were different sizes. The wall to the east represented the footing for the engine and was longer, measuring 7.5 meters (24.6 ft.) in length, a maximum of 1.4 meters (4.6 ft.) wide, and 1.5 meters (5.0 ft.) high (above grade). The structure consisted of a cement and brick wall with three separate granite blocks atop it (see Figure 29B). The cement sections of the wall were poured into a form with fieldstones added as aggregate. Three granite blocks were atop the wall, the two to the north laying across the top and measuring approximately 1.3x1.0 meters (4.3 x 3.3 ft.), although they were not precisely the same size. The third block was at the south end of the wall and measured 1.9x0.8 meters (6.2x2.6 ft.). In addition to its different dimension, this stone did not straddle the wall but rather was to the west (interior) side. The cement had been poured after the blocks were in place and so the stones were partly embedded in the wall. The stones were first placed atop brick pillars that were built around vertical iron bolts for securing the machinery. The bolts extended upward through the granite blocks (Figure 30).

The west masonry wall, representing the outer bearing mount, was smaller than the first, measuring roughly 3.0x0.7 meters (9.8x2.3 ft.), but taller, reaching a height of 1.8 meters (6.0 ft.) with a single granite block adding 0.7 meters (2.5 ft.). Like the wall to the east, this one was cement with the granite block sitting atop a brick pillar made to encase a metal bolt. The construction of this wall showed some variations, however. In particular, the masonry section incorporated layers of stacked brick alternating with fieldstone (Figure 31).

As noted the two walls represent the mounts for the steam engine and flywheel used at the stamp mill. The plant operated a Corliss engine, at least during the last part of the nineteenth and early twentieth century. The principal parts of the engine were the cylinder and bed section, the flywheel, and the pedestal outer bearing. The flywheel was suspended between the bed section and outer bearing, which was a bracket that held one end of the crankshaft. The footprint of a Corliss engine conformed to the paired masonry walls of Feature 1. The eastern wall served as a foundation for the cylinder and bed section, while the western wall was the pedestal for the outer bearing. The flywheel was suspended between them. Although these features are above ground, when the structure was still standing a wooden floor was at the top level of the eastern wall (Figure 32).

Other components of Feature 1 consisted of a stone and brick wall that partly enclosed the engine footings. Remnants of the wall were present on the west and north sides of the feature, while Feature 2 on the east side appeared to comprise a third wall. The western wall was the most coherent, being constructed of dressed and unmodified stones, with a maximum of two intact courses. A notable aspect of the walls was the use of brick in sections rather than as a course atop the stone. This was observed in the west and north walls (Figure 33). No evidence of a wall was

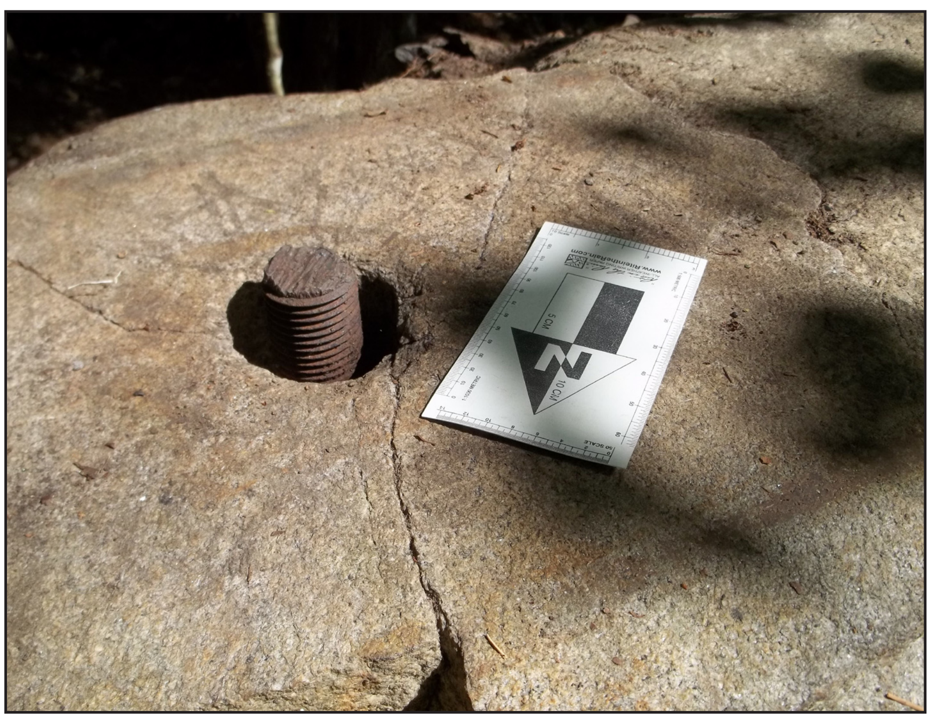
Figure 29.
Feature 1, Corliss Engine Mounts

A. Feature 1 Before Cleaning Showing Relative Sizes and Relationships of the Two Masonry Structures. Looking North

B. Engine Mount

Figure 30.
Details of the Engine Mount (Feature 1)

A. Arrangement of the Granite Blocks. (Note the Concrete with Aggregate was Poured Around the Stone)



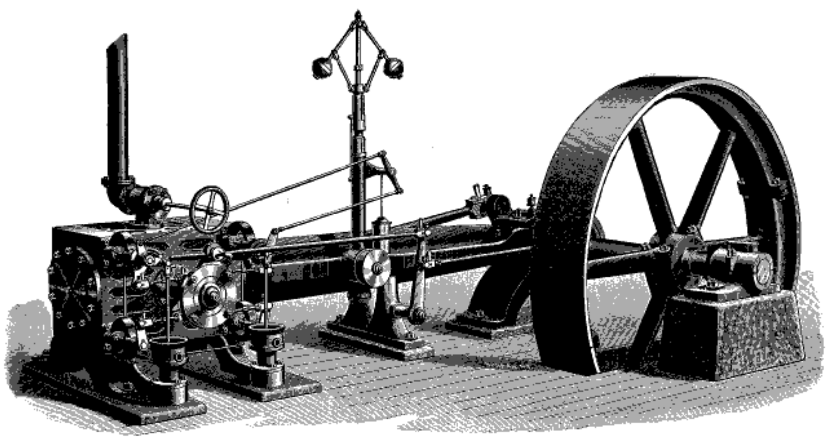
B. Iron Bolt Extending through Drilled Hole at the Southernmost Granite Block, View to Southeast

Figure 31.
Outer Bearing Mount (Feature 1)

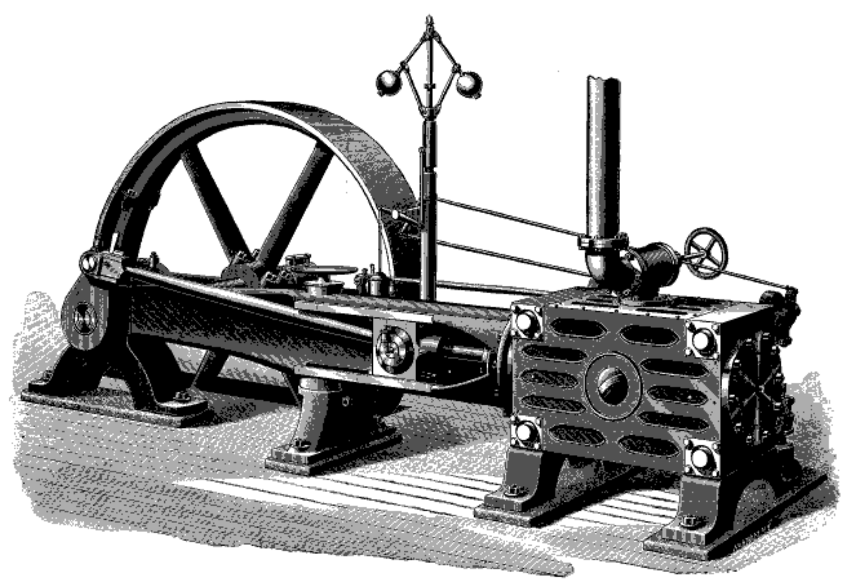
A. View to the Southwest Showing Masonry Wall with Granite Block.

B. Detail of the Wall Showing Alternate Layers of Stacked Brick and Poured Concrete with Fieldstone Aggregate, View to the East

Figure 32.
Diagram of a Corliss Engine Showing the
Arrangement of Principal Components and Mounting



THE ECLIPSE CORLISS ENGINE.



THE ECLIPSE CORLISS ENGINE.

The Manufacturer and Builder 1888

Figure 33.
Feature 1 Exterior Wall and Associated Artifact

A. Excavated Section of West Wall, with Engine Mount in Background, View to the South

B. Construction of the West Wall, View to the West

C. Iron Object East of Feature 1, View to the Northeast found on the south side of the feature, but it was unclear if this was a deliberate construction technique or if this had been lost after the site's abandonment. The masonry wall is interpreted as the foundation of the wooden engine house.

Artifacts found with Feature 1 consisted of iron straps and remnants at its northeast corner (see Figure 33C). Clearing this object revealed three straps or bands, two with "I" shaped cross-sections lying within an area 1.5 meters (4.9 ft.) long. The extant diameter of the bands was approximately 0.5 meters (1.5 ft.). Remnants of iron sheeting were inside the bands but not fastened to them. Presumably, these items reflect scraps from the equipment used in the engine or boiler house.

Feature 2

Feature 2 comprised a stone wall probably associated with the stamp mill boiler room, which historic photographs show in this area. The feature lay immediately east of Feature 1 and was formed by two intersecting walls, to the west and south that appeared to form two sides of a structure (see Figure 28). However, no evidence of walls to the north and east were identified, so it was not clear if the feature was meant as a foundation or retaining wall.

The east-west wall of Feature 2 was more visible, having an exposed face on the south. This face reached a maximum height of about 1.0 meter (3.3 ft.) above grade on the south side. On the north or interior side, however, it was filled to the top of the wall. The location of the western segment of the wall was projected from loose stones visible on the surface. A test window at the projected north end of this wall showed it extended as far as the north wall of Feature 1. Further, the small section of wall exposed here incorporated fieldstone and brick sections like those noted in Feature 1, suggesting they were built at the same time (Figure 34).

Cleaning the southwest corner and east end of the south wall revealed Feature 2 was constructed of dry-laid granite and schist fieldstone. The southwest corner contained articulated stones. The remainder of the feature, however, was not well preserved, making it difficult to interpret. Cleaning the eastern portion of the south wall, for example, did not reveal a corner. The wall here became increasingly diffuse and finally ended at a low area where erosion had washed out the ground surface. Inspection of the eroded bank did not reveal a corner or an east wall.

No north wall to this structure was visible on the surface. To find it and to look for possible interior walls or machine mounts, New South placed Trench 2 from the projected center of the feature through the estimated location of a north wall (predicted by extending the line of Feature 1's north wall). The trench was 8.0 meters (26.2 ft.) long and 50 centimeters (1.5 ft.) deep. No traces of a north wall or internal structures were found. The trench stratigraphy included a lens of light yellowish brown (10YR 6/4) coarse sand that lay only in the northern part of the trench and was interpreted as fill or colluvium. A yellow (10YR 7/6) fine silt that tapered to the south was below this and was also interpreted as possible fill or colluvium. Subsoil, consisting of strong brown (7.5YR 5/6) slightly clayey silt with gravel and rock underlay the silt. Weathered schist at the base of the trench exhibited no evidence of having a cultural origin (Figure 35).

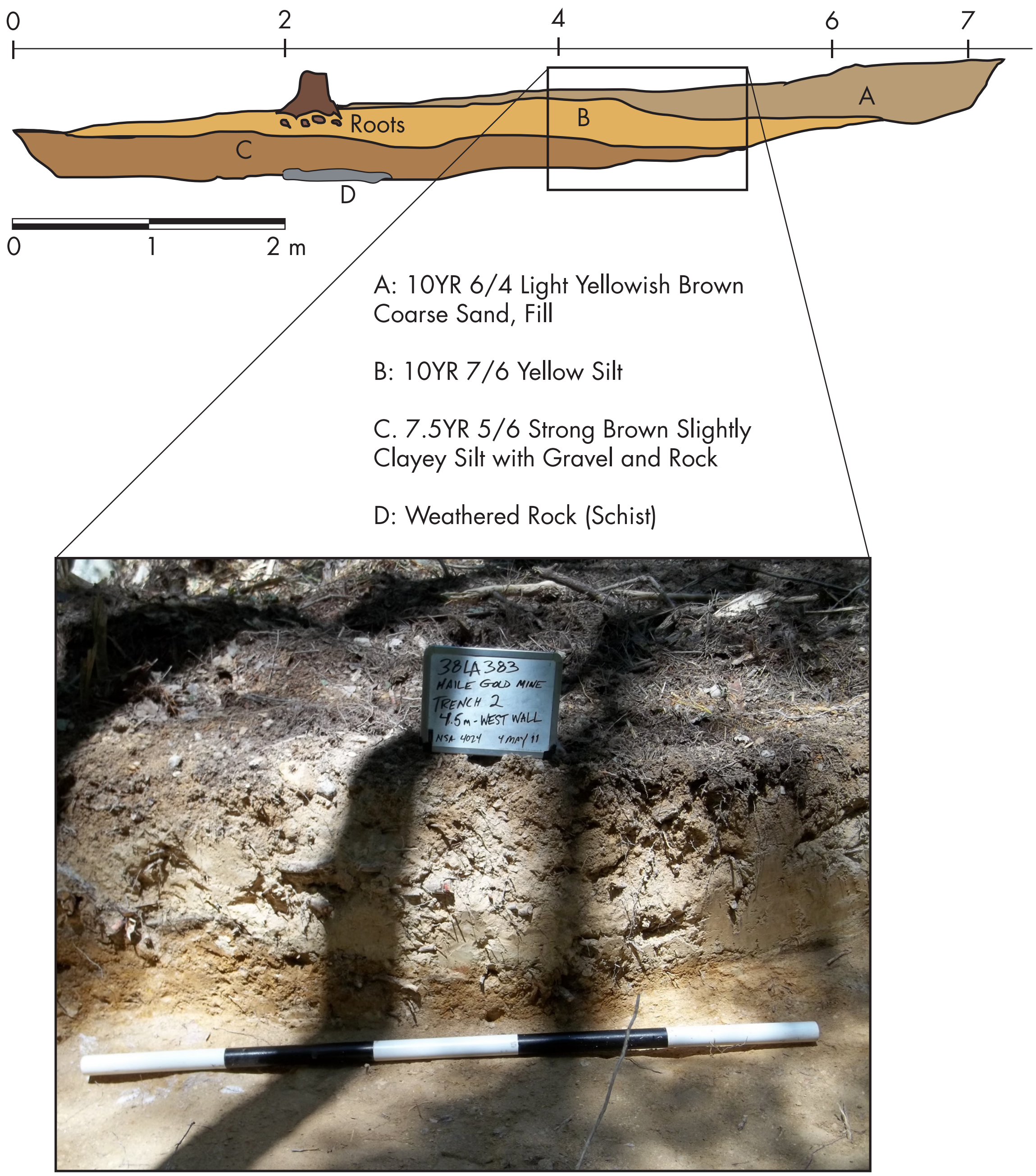
Figure 34.
Feature 2 Construction Details and Condition

A. Southwest Corner Showing Construction of Granite and Schist Blocks, View to the North

B. Eastern End of the East-West Wall Had Limited Preservation and a Indeterminate Terminus, View is to the East

C. Section of Brick and Stone Wall Exposed in Test Window. The Southwest Corner of Feature 2 is at the Total Station in the Background, View is to the South

Figure 35.
Trench 2 Profile



A. Section of Trench 2 Profile at 4.5 Meters from South End

As a result of the investigations, Feature 2 cannot be conclusively identified as either a retaining wall or building foundation. Historic photographs, however, show the boiler house, indicated by the smokestack. Although the boiler types used at the site are unknown, they would have required some kind of foundation (Peabody and Miller 1912:129). Pittman (2008:71) described them as masonry. Photographs of the site after it was converted for the pyrite mine show a different arrangement of structures in this area, and it is possible that remodeling the site resulted in the loss of certain structures associated with the stamp mill's boilers.

Feature 3

Feature 3 represented a brick pier located 4.5 meters (14.8 ft.) south of Feature 1 (see Figure 28). Measuring 73x67 centimeters (2.4x2.2 ft.) and containing four extant courses above grade (to a height of 40 cm [1.3 ft.]) this structure aligned with Feature 18, a stone and brick wall to the west. Feature 3 was distinguished by a different construction technique than Feature 18, being mortared brick rather than dry-laid stone and brick. No extant wall segment could be found to connect the two features, suggesting they were part of the same structure but built at separate times or for different purposes. Feature 3 was capped by a layer of mortar that had no impressions of brick, indicating that the mortar represented the original top of the feature (Figure 36).

Feature 4

Feature 4 was a piece of iron hardware (Figure 37). The heavily encrusted item measured just over 1.2 meters (3.9 ft.) long with a maximum width of 55 centimeters (1.8 ft.). The object consisted of a rod with a collar or nut at one end, two arms extending from an oxidized central section, and a large encrustation at the other end. The shaft diameter measured approximately 20 centimeters (8.0 in.) and terminated with a narrow pin or bolt at the collared end.

Excavation revealed this object was buried in gray (10YR 6/1) and yellow (10YR 7/6) clay. The object was clearly out of context and reflected refuse and materials scattered after the site's abandonment. Its function could not be specifically identified, but it is interpreted as a machine part.

Feature 7

Feature 7 consisted of a group of features including two cement walls, an earthen mound, and artifacts found in the mound (see Figure 28). New South examined the mound and one of the cement walls with a backhoe trench (Trench 1). The spatial relationship of these features to others, such as the boiler and engine houses and the railroad (Features 13 and 14), combined with map and photographic evidence, indicated that Feature 7 was part of the stamp mill, although the specific component of the mill was not clear.

As originally identified, Feature 7 consisted of a dome-shaped mound, measuring approximately 10x9 meters (32.8x29.5 ft.) and 3.5 meters (11.5 ft.) high. A massive masonry structure measured 3.2x1.1 meters (1.5x3.6 ft.) extended from the top of the mound (Figure 38). Its south face was exposed, allowing it to be partly excavated and measured. The height of this structure was 2.7 meters (8.9 ft.) and it rested on weathered schist bedrock. The structure was built from

Figure 36.
Feature 3 with Associated Features

A. View to the Northeast with
Feature 1 in Background

B. View to the Southwest Showing
Alignment with Feature 18
(Stone Wall in Background)

Figure 37.
Feature 4

A. Iron Object Partly Excavated and Showing its Context, View is to the West

B. Complete Artifact

Figure 38.
Feature 7

A. Feature 7 Consisted of a Masonry Structure Partly Buried in an Earthen Mound, View to the West after Clearing for Excavation Machinery

B. A Test Window at the South End Indicates Feature 7 Sat Directly on Schist Bedrock, View to the Northeast poured cement with large rocks added as aggregate. The impression of the wooden framework used to support the structure indicated it contained massive 12x2-inch planks that crossed over the sides of the structure and attached to vertical 12x12-inch posts at the corners (Figure 39). Also at the corners were remnants of vertical iron rods. One of these had a turnbuckle on it that was embedded in the cement, where it probably could not be adjusted. The rods therefore probably served to support the wooden frame rather than the cement structure or as equipment mounts.

At the base of the mound, south of this structure, there was a second, smaller poured cement structure measuring 1.3x0.6 meters (4.3x2.0 ft.) and 85 centimeters (2.8 ft.) above grade. It was constructed similarly to the larger structure, being poured cement with stone aggregate, and did not exhibit any evidence of a superstructure (Figure 40).

Trench 1 was placed across the north end of the larger cement structure in the east side of the mound (Figure 41). The trench measured 4.0 meters (13.1 ft.) long, 2.0 meters (6.6 ft.) wide, and reached 1.0 meter (3.3 ft.) deep before excavation stopped for safety. To that depth, the mound consisted of a single deposit of light gray (5Y 7/1) silt with schist of the same color or brownish yellow (10YR 6/8). Watkins (1918:521), describing the operation of the pyrite mill, observed that, "the overflow from the settling tanks is a finely divided white powder that feels like talc powder. This material represents the sericite in the schist after most of the free silica has been taken out." The mound fill matched this description, indicating it probably reflected processing residues of the pyrite plant.

Moreover, the discovery of discarded metal and wood objects buried within this deposit suggests that the mound reflects clean up of the site after the pyrite operation ceased (Figure 42). (The time period when this clean up took place and by who is not known at present.) The finds consisted of a mangled rectangular iron frame with four attached rods. The two long sides were rods measuring 5.0 centimeters (2.0 in.) in diameter. At one end, they linked to a 10-centimeter (3.9-in.) diameter rod with a pair of large collars that appeared concentric to the rod. The ends of the rods were threaded, inserted into yokes at the base of the collars, and secured with nuts inside the yoke and lock nuts on the outside. At the opposite end of the artifact, the connecting collars were smaller and less elaborate, but because of heavy encrustation, they could not be described precisely. The function of this object could not be determined, but it probably operated as part of a mechanism wherein the larger rod revolved to oscillate the frame.

In addition, several pieces of lumber, some burned, were found in the base of Trench 1. No distinct soil changes were associated with these finds to suggest they had been deposited on a now-buried surface. Moreover, the metal frame was bent against the cement structure, indicating these materials were dumped here, and, along with mound, probably reflect site clean up.

A Coca Cola bottle base was also recovered from Trench 1. The straight-sided bottle, produced in a two-part mold, was embossed on the base "7 OZ//COCA-COLA [in traditional script]//g [or 9]//71". The foot contained a partial emboss, ". . . DEN, S.C." on one face and "PROPERTY OF COCA . . ." on the other. The mark referred to the Camden Coca Cola Bottling Company, which operated between 1916 and 1919. The date range of this artifact is consistent with the period when the pyrite mill operated and provides a terminus post quem for the Feature 7 mound.

Figure 39.
Feature 7, Construction Details

A. Mold Marks Indicated the Cement was Poured into a Form Built with Massive Wood Beams and Planks, View is to the East

B. Top of Feature 7 Showing Molds of Wood Beams, View to the Southwest

Figure 40.
Feature 7, Small Masonry Structure

A. The Smaller Structure (at Right) in Relation to the Larger Structure and Mound, View is to the Northeast

Figure 41.
Feature 7, Mound Profile (Trench 1)

A. Trench 1 North Profile

B. Trench 1 South Profile Showing Stratigraphic Context of the Masonry Structure and Artifacts Exposed at the Base of Trench

Figure 42.
Artifacts at Base of Trench 1, Feature 7

A. Iron Object with Burned Wood, View to the West

B. Plan, Looking Southwest

C. Detail of Rod and Connecting Collars, View to the Northeast

The cement structures related to the stamp mill but their function is not clear. A series of features to the northeast (Feature 14) were interpreted as railroad supports, while features to the southwest (Feature 16/17) possibly reflected the stamp batteries. Thus, Feature 7 lay between these two activities (ore delivery and stamping). A possible function is that this structure supported the ore bins, which had an 800-ton capacity and which were located on an upper story of the mill.

Alternatively, it might have been used to support some of the heavy breaking and crushing machinery used for the pyrite mill. Ideal practice was to arrange the ore handling process vertically and allow gravity to move the materials forward from one stage to the next. This practice necessitated multi-story structures with some of the heaviest machinery, such as breakers and crushers, on the upper stories. Extremely substantial foundations and mounts were therefore necessary to support this equipment and it is possible that Feature 7 reflected the crushing apparatus used at the pyrite plant. Another possible interpretation is that this feature supported a large feeder or bin added to the building for the pyrite mill (see Figure 11B).

Feature 8

Feature 8 consisted of a square cut into the slope just west of the smaller Feature 7 cement structure. This ambiguous feature was not clearly cultural but was designated as a feature because of its shape and associations. It measured approximately 2x1 meters (6.6x3.3 ft.) and was located at the head of a north-south running swale that was associated with several wooden structures (Feature 17). No investigation was made Feature 8 except mapping.

Feature 16/17

Feature 16/17 was a reference to a complex of wooden structures, isolated wood beams and planks, and crushed rock deposits within a roughly 16x9-meter (52.5x29.5-ft.) area southwest of Feature 7 and west of Feature 1. This area roughly corresponded to the projected location of the stamp mill, and the features were interpreted as remains of the stamp batteries or other equipment and discarded or spilled tailings. The area was also bounded by a swale on the west, another less distinct swale or low area on the east, and a relatively sharp drop off on the south, which was marked by a rock wall or foundation (Feature 18). The Feature 7 mound was at the north end of this area. The contours created a distinct terrace that sloped slightly to the southwest (See Figure 28).

This feature was marked by three structures built of wood posts at its margins. One (Feature 16) was at the eastern margin, while two others (Features 17A and 17C) were at the west side. Additional wood remnants included two isolated posts embedded at the west edge of Feature 17, smaller posts in the interior, a partly buried horizontal beam in the interior, and a loose beam or post.

Features 16, 17A, and 17C were tentatively interpreted as remnants of the stamp batteries (Figure 43). These three features consisted of groups of 30x30-centimeter (1.0x1.0-ft.) square beams set upright in the ground. This configuration matched the description of stamp mortar blocks that Louis (1902) and Roberts (1909) provided. The ideal size of the blocks was 0.5-0.8 meters (1.6-2.5 ft.)

Figure 43.
Feature 16/17 Wood Structures

A. Feature 16, View to the West

B. Feature 17A, View to the Southeast

C. West Side of Feature 16/17 with Feature 17C in the Foreground and Ditch to the Left. Feature 7 (Mound) Visible in Background, View to the Northeast wide and 1.2-1.5 meters (3.9x5.0 ft.) long. Feature 16 measured 1.3x0.5 meters (4.3x4.6 ft.), making it a close match of the standard. Feature 17A was about 1.7x1.1 meters (5.6x3.6 ft.) but poor preservation made it difficult to define. Feature 17C measured 2.8x1.1 meters (9.2x3.6 ft.), its longer-than-expected length possibly indicating remnants of side-by-side batteries.

Although the construction of these wooden features is consistent with what would be expected at a stamp mill, the variation in size and arrangement could indicate they relate to the pyrite mill. Watkins (1918:520) stated that jigs, rolls, and crushers replaced the stamp mills when the building was renovated for the pyrite operation. Mechanical rollers and other crushing and grinding equipment also consisted of heavy machinery that required substantial support. Moreover, the practice of placing heavy equipment on upper stories of the mill to enable a gravity-fed flow meant that mill buildings required considerable support, and the wooden pilings could also reflect those functions.

Inside the rectangular area defined by Feature 16/17, there were additional remnants of the stamp/pyrite mill (Figure 44). Among these was a 30x30-centimeter (1.0x1.0-ft.) beam section measuring 2.8 meters (9.2 ft.) long with a roughly 50-centimeter (1.5-ft.) house joint on one face and several iron bolts through it. Presumably, this item represented the building's framing, although it could have been part of a machine mount.

Finally, this rectangular area contained discrete piles and general scatters of crushed stone. The stone was a white quartz ground to coarse-sand and was interpreted as either discarded or incidental tailings or concentrates from the stamp/pyrite mill.

Feature 18

Feature 18 comprised a 13.8-meter (45.3-ft.) long stone and brick wall that extended across the south edge of the area that Feature 16/17 delineated and extended eastward toward Feature 3 (see Figure 28). This feature was not substantial, being composed of fieldstones and partly dressed granite blocks arranged in a row of single stones one course high. The rocks varied considerably in size and at the east terminus, a 50-centimeter (1.5 ft.) segment was brick (Figure 45). The feature did not extend as far as Feature 3 (the brick pedestal) to the east but did align with it, the gap possibly representing a doorway. The location of this feature at the top of a short slope to the creek floodplain suggested it marked a break in the terrain.

Photographs of the stamp mill and later pyrite mill indicate that several structures were built along its south face of the main building. These were typically one-story additions with shed roofs. The unsubstantial quality of Feature 18 suggests it might have functioned as a foundation for one of these structures. Photographs of the pyrite mill indicate that these structures took advantage of the change in elevation to facilitate loading. The shed had an ore chute that fed trucks parked below on the floodplain (Watkins 1918:518).

Figure 44.
Associated Remnants of the Stamp/Pyrite Mill (Feature 16/17)

A. Overview of Feature 16/17 Showing then Area Delineated by the Level Surface and Ditch (Right), View to the South

B. Feature 17E, Wood Beam, View to the Southwest

C. Feature 16/17 with Crushed Rock (Low White Mound in Center). Feature 7 is in Background, View is to the North

Figure 45.
Feature 18

A. Feature 18 Composed of Granite Stones that was Only One Course High and Deep, View to the Northwest

B. The Feature's West End, Shown Here, was at the Top of a Slope and formed a boundary for Feature 16/17 at left, View to the East

C. The East Terminus of Feature 18 was Brick, View to the West

Feature 21

This feature comprised a brick pier located just west of Feature 16/17. Feature 21 was exposed under a push or spoil pile. The extant portion measured 50x30 centimeters (1.5x1.0 ft.) and reached a height of 50 centimeters (1.5 ft.), equaling five courses. The south and east sides of the feature appeared intact while the north and west were fragmentary. The base was laying on clayey subsoil while the uppermost course had no mortar on it, suggesting the extant portion represented the actual height (Figure 46).

Although Feature 21 resembled Feature 3 in materials, it was offset from Features 18 and 3 and did not seem to form part of the same structure. Historic photographs show an ell and small sheds on this side of the main building and Feature 21 could relate to one of these. No similar features were found in the immediate area to delineate a complete building footprint.

Stamp/Pyrite Mill Summary

This group of features thus comprises the remains of the stamp mill and pyrite mill that replaced it along with the stamp mill's power plant and engine room (Features 1 and 2). Historic maps and photographs provide information for correlating the features to the former structures. Two maps provided measured plans of the mill and mining property. The earliest of these, Nitze and Wilkens (1896), depicted a large rectangular building with its long axis running southwest to northeast and its interior divided into four smaller spaces, including a room with a "bay" on its east side, which was the engine room, and an ell projecting from the southwest corner that represented the concentration shed. A 1906 sketch map of the mine shows the same footprint but without the bay (Pluckhahn and Brayley 1993:18).

No other maps illustrating the building show this configuration. Schrader's (1921) map, for example, portrayed the overall mine property arranged roughly the same way Nitze and Wilkens did. However, Schrader showed the mill oriented northwest to southeast and without the projecting bay and ell. This shape is almost certainly not accurate, as photographs of the pyrite mill indicated that it had essentially the same footprint as the earlier stamp mill (compare Figures 8 and 11). Thus, for this analysis, Nitze and Wilkens' map is considered more reliable.

Scaling Nitze and Wilkens' map indicated a building measuring roughly 25.9x18.9 meters (85x62 ft.), with the concentration shed adding 11 meters (37 ft.) to the east-west dimension. Overlaying the historic map on the site plan revealed a close agreement between the illustration and the archaeological features (Figure 47). Using Features 1 and 2 as a reference point because their functions are clear, the stone wall encircling the engine mount corresponded closely in size to the room with the bay on the east side of the mill. If this projection is correct, then Features 3 and 18 match up with the southwest side of the building, with Feature 3 at the corner. Also, the projected northwest side of the building lines up with Feature 17. Finally, the mine railroad shown on Nitze and Wilkens' map also lines up with Feature 14 (described below).

Figure 46.
Feature 21

A. Feature 21, A Partial Brick Pier, View to the Northeast

B. Feature 21, Not Aligned with Nearby Features Such As Feature 18, Seen at Far Right, or Feature 16/17, View to the East

The map and archaeological finds do not conform perfectly, and there are features that are not accounted for. The south face of Feature 2, for example, did not fit well with the projected footprint of the mill. This feature, however, could represent the boiler room or a later structure associated with the pyrite mill. Feature 7 did not clearly relate to the projected mill footprint either, but its position in roughly the location where the mine railroad dumped ore at the top of the mill indicated this feature was probably supported the railroad and ore bins.

Other elements of the mill were not identified archaeologically. No evidence of the concentrating shed was found, except possibly Feature 21, which lay along its projected north wall. Moreover, some features could not be clearly associated with the map data. Feature 16, for instance, could represent a stamp battery or structural remains.

The organization of mill-related features across the site landscape reflects certain established guidelines of mill construction and arrangement. One of these is the vertical organization that allowed gravity to move the ore through various stages. Roberts (1909:572) distinguished three types of mill sites: 1) a hillside or terraced site with a sloping mill; 2) a flat site with a sloping mill; and 3) a flat site with a flat mill. The Haile Gold Mine mill seems to represent a hybrid with aspects of the first and second classes. Rather than being built on terraces excavated into the slope, grading for site preparation was done only at the base of the slope, where the area encompassed by Feature 16/17 was leveled along with the area of Features 1 and 2, as indicated by the contours and possible retaining wall (Feature 2). Placing the site at a relatively broad, gently sloping area at the foot of the ridge minimized the amount of earthmoving required.

A disadvantage of the flat site with a sloping or vertical mill was that the ore had to be elevated at the start of the process (Roberts 1909:572). At Haile, placing the mill adjacent to the ridge allowed ore delivery to the top floor with a short ramp from the ridge crest (see Feature 14 below). Another disadvantage was that the higher end required substantial framing and foundations (Roberts 1909:572-573). The upper story of the Haile mill containing the ore bins and ore car terminal required aboveground support, which was presumably accomplished with heavy framing and wood supports; no evidence of substantial masonry foundations was observed at the site.

Roberts (1909:573) noted that the power plant was typically located in a separate, smaller building to one side of the mill. In this case, Haile followed the usual pattern. Roberts (1909) said that other buildings associated with a mining operation could vary in location and arrangement. Carpenter-, machine-, and blacksmith shops normally served not just the mill but also the mine. At Haile, these shops were located at a distance from the mill in a more central location relative to other parts to the entire operation.

Concerning the construction of mill buildings, Roberts (1909:573) emphasized strength and solidity. He remarked especially on the need for strong foundations and framing to hold the weight of ore bins, heavy machinery, and vibration, while other authors (e.g., Del Mar 1919:72) reiterated this emphasis. Examination of the Haile stamp mill remains, combined with archival

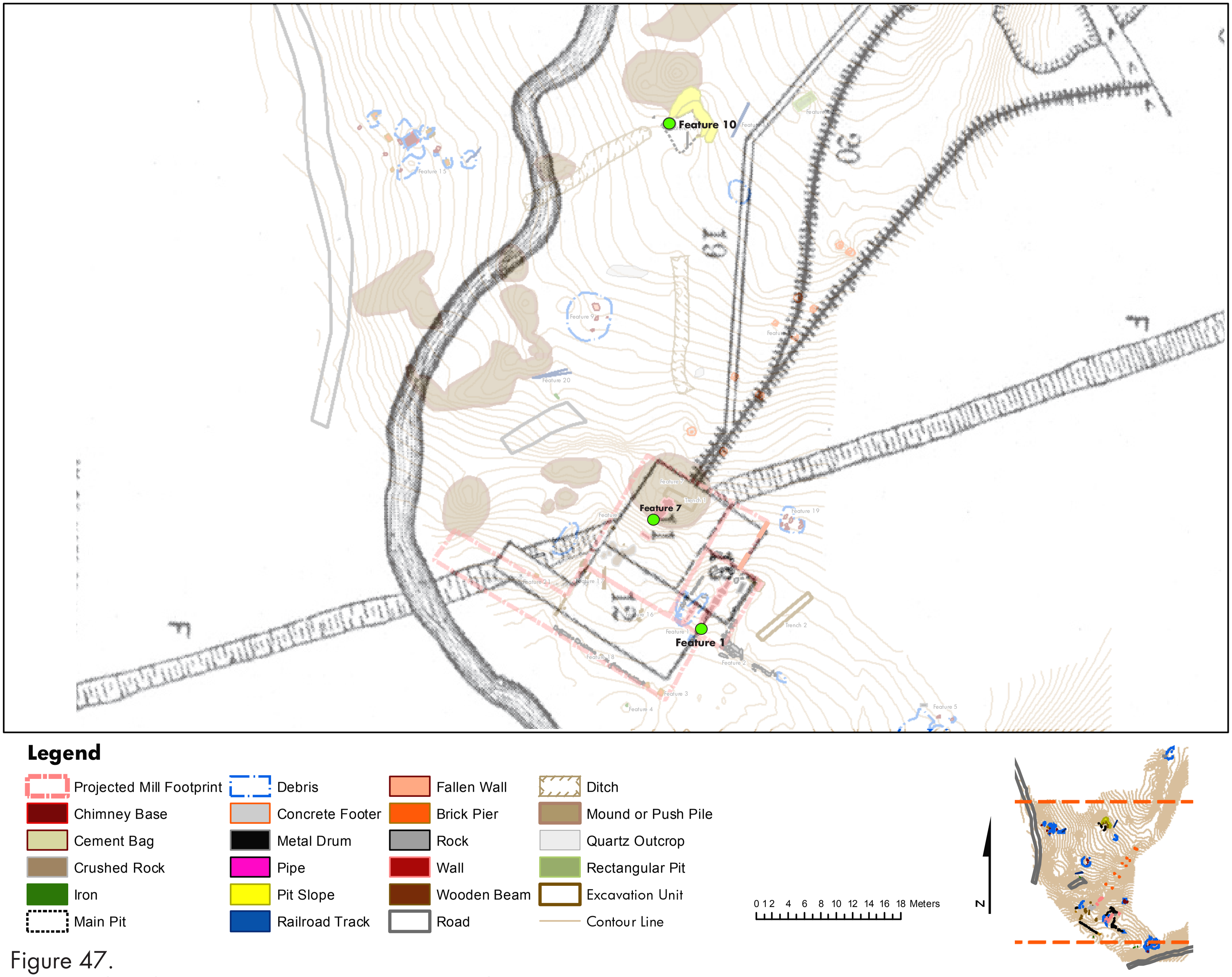


Figure 47.
Nitze and Wilkens' (1896) Map Superimposed on Site 38LA383

sources, suggests that the support structures were not particularly substantial, although there was variation. Feature 1, for example, included massive structures to support the Corliss engine, but the building around it was evidently built on a relatively insubstantial foundation. Similarly, investigation of the mill building itself did not provide evidence of a very strong underpinning except for Feature 7. Feature 16/17, the wood pier structures, was interpreted as probable machine mounts rather than building supports.

The absence of a large foundation is difficult to explain. The mill building was a substantial, three-story structure that had to support not only the ore bins, but also the stamps (although these were also based on dedicated mortar blocks), amalgamation tables, and other equipment, as well as the ore cars when they delivered. Masonry was commonly used for foundations and machine mounts, ideally using quantities of binding material and extending them to bedrock. Moreover, foundation walls should be at least 20 inches wide at the top (International Library of Technology 1902:24.20). Thus, the Haile Mill was almost certainly built on foundations more substantial than the possible one that Feature 18 represented. Possible reasons for the lack of these is that they were removed, they were buried by grading and colluvium, or they never existed and the mill was supported on pilings that decomposed to a point where they were not readily visible on the ground surface. Alternatively, the wooden structures comprising Feature 16/17 might represent building foundations rather than stamp blocks, as suggested by comparing the site map with the building plan (see Figure 47).

Finally, although there was no clear archaeological evidence of the mill's superstructure, photographs of the site indicate it was a large frame building with a rectangular footprint. The central structure was three stories with numerous windows. On the west side, there was a shed-roofed two-story addition that presumably housed some of the stamp batteries. The power plant was in a small one-story addition or possibly two separate buildings attached to the east side. Another unit, possibly with two stories, was built across the south side of the mill to house the concentrating operation (Pittman 2008). The 1908 boiler explosion mainly damaged the east side of the mill building and concentrating house. Photographs of the repaired structure suggest a similar footprint with modifications to the concentrating house and possibly to the boiler and engine house (Watkins 1918:58).

In this interpretation of the mill it is worth noting the probable sequence of its construction, which is known mainly from archival sources. Gybbon Spilsbury built a 20-stamp mill. Later, Carl Thies added 40 additional batteries in two separate building events. Contemporary diagrams imply this equipment was inside a symmetrical structure with stamps along each side and feeder bins in the center. The central part of the building was shown as narrow and having sheds on either side that housed the stamps (see Figure 7).

Photographs, however, indicate the stamp mill was not symmetrical. Rather, it consisted of a large three-story building arranged for the ore cars to arrive on one side of the building rather than the center (see Figure 9). The photos also show a 1.5 or two-story high shed addition on the northwest side. The larger main building presumably represents the original structure that housed the first 20 stamps in the southeast side of the building. Thies built the shed addition for either the first or second set of supplemental stamps.

The photograph of the mill after the boiler explosion shows some of the framing exposed, indicating a sturdily constructed building with knee braces on the main posts and smaller studs between them. In contrast, the exposed framing of the concentrates shed appears to consist of less substantial 2x4 studs, conforming to the notion that, "Small buildings about mills can be framed of small stuff, without any special framing, the pieces simply being spiked together to form a balloon frame, which is covered with either siding or corrugated iron" (International Library of Technology 1902:24.27). Both the mill and associated structures were clad in horizontal siding.

FEATURES ASSOCIATED WITH THE STAMP MILL

Several features did not directly reflect the stamp/pyrite mill but were components of the overall system of operation. These included Features 10, 13, and 14. Features 11 and 20 consisted of loose railroad rails from the small-gauge track used to transfer the ore between the mines, stamp mill, and chlorination plant (Figure 48).

Feature 10

Feature 10 is interpreted as the reservoir for the stamp mill and possibly pyrite plant. The feature consisted of a large square pit measuring 4x4 meters (13.2x13.2 ft.) and 2.0-3.0 meters (6.6-10 ft.) deep (Figure 49). For the safety reasons, the pit was not entered, and therefore its base was not mapped. In addition, the edges of the pit had eroded, expanding its size at the top to about 5x4 meters (16.5x13.2 ft.). Wood post remnants at its northeast and southeast edges marked its actual edges.

An iron pipe extended from the south corner of the pit for a distance of 1.9 meters (6.27 ft.) and terminated at roughly the pit's center. The pipe was situated about 50 centimeters (1.5 ft.) below the rim of the pit. The orientation of this pipe put it in a line to intersect the stamp mill. Probing and a test window outside Feature 10 failed to find an extension of this pipe along the projected alignment, indicating it was removed. Although it is possible that it was elevated to deliver water to the upper floor of the mill, a photograph of the mill indicated that there was no such elevated pipeline coming from the direction of Feature 10 (Pittman 2008:18).

Another, smaller metal pipe was just outside the west corner of Feature 10. This buried pipe was not excavated to determine its size or orientation, but it might relate to the flume that ran between the reservoir and the pond at the north edge of the mine complex. Alternatively, it could have supplied water to the houses located near the mill (e.g., Feature 15).

Water was integral to the stamp and concentrating processes. Water was fed into the mortar boxes along with the ore and washed the crushed material across the amalgamation tables. It was also used to separate valuable material from gangue in the concentrating shed. Although there is little specific information about how the pyrite plant operated, it might have used wet crushing methods and it is known that the plant used jigs for concentrating, which relied on water. Therefore, it is probable that the pyrite operation retained the use of a reservoir. Water was also necessary for the steam boilers and for fire protection (Richards 1909:582).

Figure 48.
Features Associated with the Stamp Mill

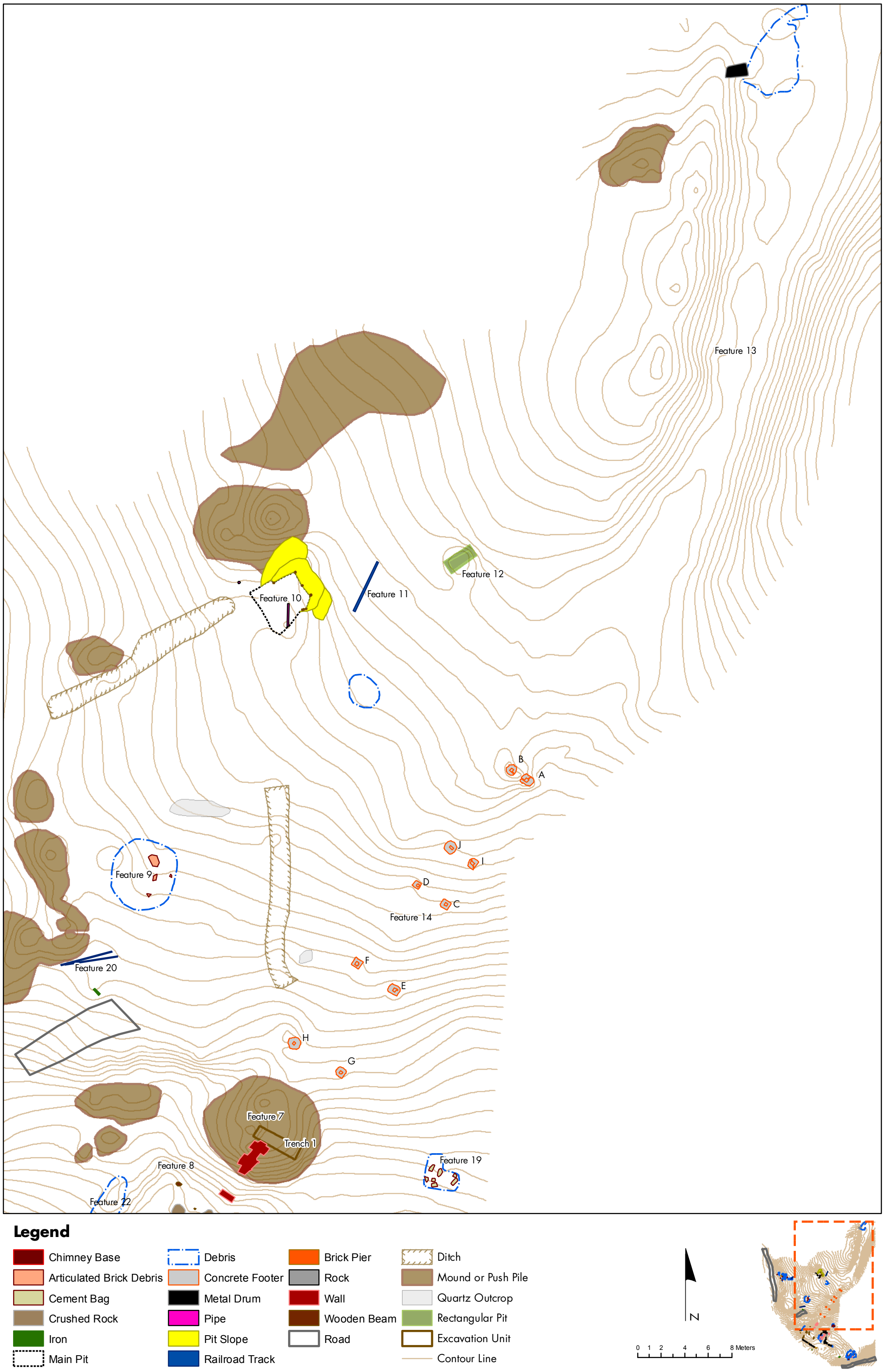


Figure 49.
Feature 10, Reservoir

A. Feature 10 Consisted of a Square Pit with a Metal Pipe Extending to its Center. The Arrow Marks a Second Underground Pipe, View to the Southwest

B. Wood Post on North and East Sides of Feature 10, View to the East

C. Underground Pipe at Southwest Corner of Feature 10 View to the Southwest

The reservoir was filled from the pond at the north side of the mine complex. The pond was an artificial impoundment of Haile Gold Mine Creek. A flume or aqueduct carried water from the pond to the reservoir (Nitze and Wilkens 1896; Pittman 2008:20-21). The actual form of the reservoir is not known. The pit suggests it was below ground and if so, then a pump would be required to elevate water to the pipe. Alternatively, the reservoir might have consisted of an aboveground tank and then the water could feed into the pipe via gravity. Pittman did not describe the methods used. Richards (1909:582-583) noted that both options were possible, although if a pump was used, then a source of power for it was necessary. This could include a dedicated power plant or a connection to the mill's power source if it was close enough. The photograph of the mill in Pittman (2008:18) does not show any evidence of belting or power lines between the plant and reservoir. Inspection of the archaeological remains also did not indicate the presence of machinery or power sources for pumping. Therefore, at this time, the reservoir's actual appearance and mode of operation are not known.

Another method for supplying water was with elevated tanks. A photograph of the mill after renovations for pyrite processing shows an apparent water tower on the east or northeast side of the stamp mill.

Feature 13

Feature 13 was a massive cut through the ridge crest north of the site (see Figure 48). Measuring 2.5-5.0 meters (8.25-15.5 ft.) wide at the base, and as much as 15 meters (49.5 ft.) wide at the top, this cut represented the railroad line used to bring ore from the mines and concentrates to the chlorination plant (Figure 50). The extant portion was 55 meters (181.5) long and was oriented roughly north-to-south. No remnants of track or railroad ties were observed in the bottom of the cut. North of the cut there was a massive twentieth-century excavation pit that probably truncated portions of the railroad cut and certainly removed other remnants of the rail line. Piles of boulders and a large metal tank at the north end of the feature reflected dumping, probably associated with the twentieth-century pit.

Feature 13 was northeast of the stamp mill. Overlaying Nitze and Wilkens's (1896) map of the mine on the site map indicated that the feature reflects a section of the railroad line that ran between the crusher and the stamp mill. A spur at about the north end of Feature 13 went to the Haile Pit, but this connection was destroyed by more recent mining activities.

Nitze and Wilkens (1897) described this line as narrow gauge with bottom-dumping cars that held three tons. The eight car-train was filled from ore bins at the breaking stations and hauled to the stamp mill by a small saddle-tank locomotive (Nitze and Wilkens 1897; Watkins 1918:520; Pittman 2008:26).

Feature 14

Feature 14 reflects another segment of the railroad line servicing the stamp mill or a similar structure associated with the pyrite mill. The feature consisted of 10 cement footings or settings for wood trestles. These were arranged in pairs down the slope between the south end of Feature 13 and Feature 7, indicating they reflected the ramp that carried the ore cars to the stamp mill (see Figure 47, Figure 51). Pittman (2008:28-29) said of this structure, ". . . the narrow gauge railroad came off the brow of the hill and ascended by a trestle ramp into the 3rd story of the building."

Figure 50.
Feature 13, Railroad Cut

A. View to the Southwest. The Stamp Mill was at the End of the Cut in this Direction

B. View to the Northeast

Figure 51.
Feature 14, Setting and Arrangement of Cement Footings

A. View Southwest, Towards Stamp Mill (Feature 7 In Background), Pink Flags Mark Cement Footings

B. Looking Upslope (Northeast) from Feature 7, Pink Flags Mark Cement Footings

Notably, the 10 separate footings exhibit considerable variation (Figures 52 and 53). Shapes include squares, ovals, and partly squared and rounded forms. Sizes ranged from specimens having a longest dimension of 0.6-1.2 meters (2.0-4.0 ft.). Additionaly, the surface of each varied, some being flat and others convex. Finally, the cement also varied, with some containing few or no visible inclusions while others contained large stones and brick fragments as aggregate. Because the footings were not fully excavated, their ultimate depths could not be determined.

Each footing had a mold of the wood post, and again, there was considerable variation in depth and shape. In most cases, the postmold had a cement base, indicating the posts had been set into wet cement. The depths from the top edge of the postmold to the base varied from 2.0-32 centimeters (0.8-13 in.). In addition, the post shapes varied between squares and rectangular. Sizes of square molds were 40x40 centimeters (1.3x1.3 ft.) while rectangular ones were more varied, with long sides between 30 and 40 centimeters (1.0-1.3 ft.) and widths of about 20 centimeters (8 in). Several of the posts also had evidence of boards or planks being sistered to them, while one square post contained four nails, one on each face at roughly the same level. The postmolds that were deep enough to show the plumb of the post indicated a slight lean to the center of each pair, which would be consistent with their function as trestles.

The variation in size, shape, and texture suggests a rather unsystematic construction process for these footings. The more square ones implied the use of a form to shape them, while the oval and hybrid types appeared to have been shaped by the excavated posthole. The variation suggests that these were not installed all at once, but in two or more events, possibly as a means of shoring up an existing structure—maybe at the time the mill was rehabilitated for the pyrite plant. The variations in post size and shape, and the presence of attached planks and the nails in one example also imply an indiscriminate approach that possibly used recycled lumber.

As with other features, it is not entirely clear if Feature 14 reflects the gold stamp mill or the pyrite plant. The ramp to the third floor of the stamp mill was well known from photographs and accounts of the gold mining operation, but an illustration in Watkins (1918) shows an elevated track leading to a structure, probably an ore bin, on the north side of the pyrite mill. Earlier photographs show the ramp as consisting of square pile bents with batter braces. These might have been embedded in the cement footings, although rock or earth mounds at the base of each bent obscured them (see Figure 8A).

The ramp for the pyrite mill was a new structure, indicated by a higher elevation (see Figure 11). Neither photograph suggests why each cement footing pair was increasingly further apart. Moreover, the cement piles seem rather flimsy for supporting a railroad. Ideally, the trestles were built on piles driven deeply into the ground or were supported with sills and mudsills atop masonry foundations. Foundations laid like rubblework would degrade from the trains constantly passing (International Library of Technology 1902:24.25). In this light, the cement foundations might have served adequately for a small-gauge train making a limited number of passes each day, but they do not seem to be particularly sturdy, especially the ones with very shallow postmolds.

Figure 52.
Feature 14, Cement Footings

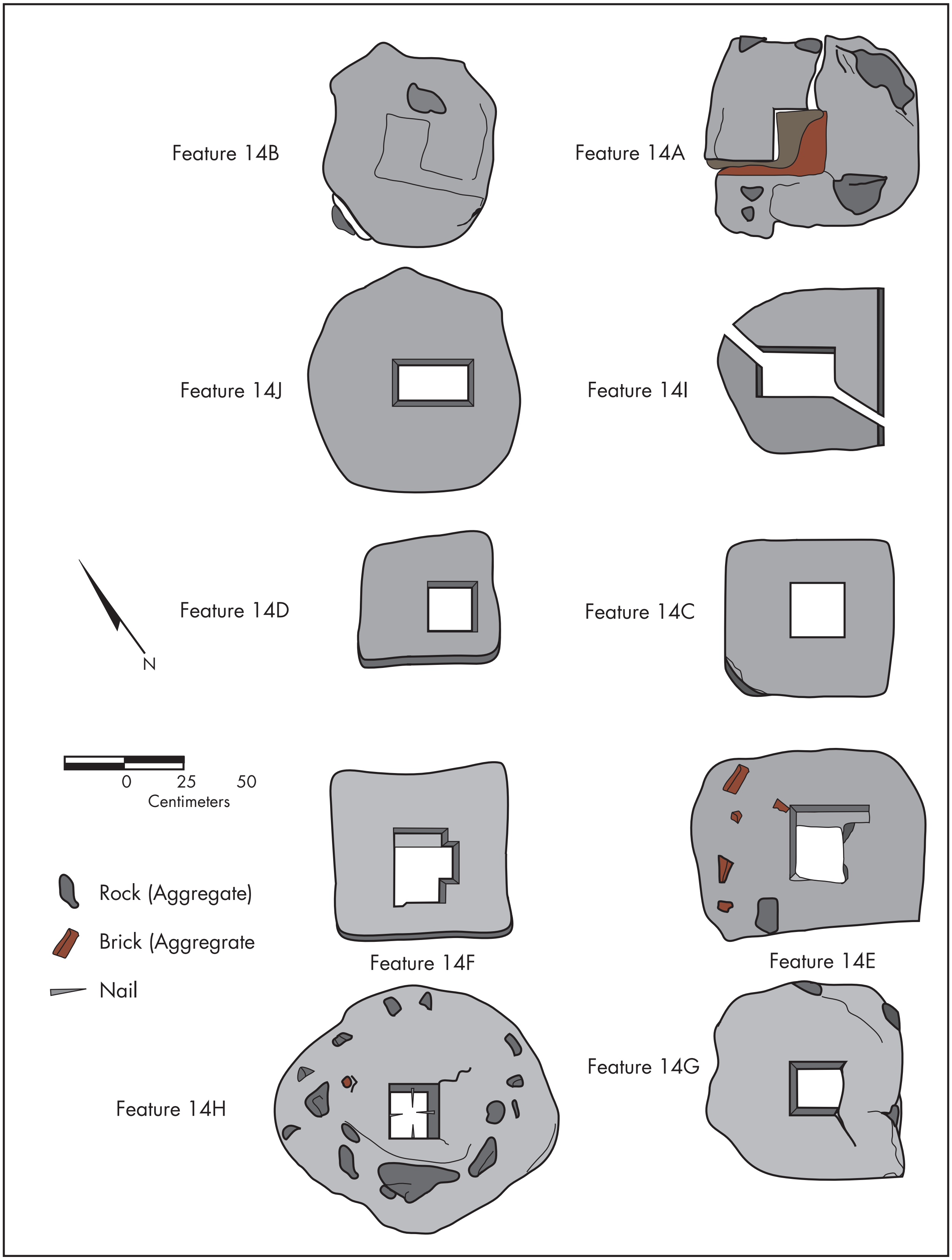


Figure 53.
Representative Photographs of Feature 14

A. Feature 14D

B. Feature 14E

C. Feature 14G

Features 11 and 20

These two features represent railroad rails scattered in different parts of the site. These were not attached to ties and no associated railroad tackle was identified with them. Given their locations and situations, these rails constitute secondary deposits. They represent remnants of the small-gauge line that once ran through this part of the mine complex.

A possible road trace was noted adjacent to Feature 20 that was not designated as a separate feature. This trace did not appear clearly on the contour map of the site but was visible on the ground as a shallow incised ledge running across the contours. This feature might represent a remnant of the rail spur that branched from the main line to the stamp mill to remove the sulfides from the concentrating shed (Pittman 2008:29).

NON-MINING OR INDETERMINATE FEATURES

Several of the features recorded during the fieldwork did not relate directly to mining activities, although they were associated with the mine. Others could not be identified as to function or were clearly post-occupation features.

Feature 15

Of the features associated with the mine but not involved with mining, Feature 15 was the most significant. Probably representing one of the houses that Pittman (2008:i) indicated near the stamp mill, this feature lay 90 meters (297 ft.) northwest of the mill. The feature encompassed four and possibly five extant brick piers surrounding a brick chimney base. Several deposits of brick rubble, some including articulated brick wall segments, were also scattered in the feature area along with an isolated railroad rail (Figures 54 and 55).

Extant brick piers were at the west and east corners as well as along the northeast and southwest walls. A possible fifth pier to the south was out of alignment with the others, suggesting it had been pushed out of place. Inspection of projected pier locations in the north and south did not find any remains of intact brick footings. Two opposing corner piers indicated the building measured approximately 10x4.5 meters (33x15 ft.), the long axis running northwest-to-southeast with corners at the cardinal directions. The piers exhibited variations in size and shape. The smallest, along the northeast side, measured approximately 40 centimeters (1.3 ft.) square and the one on the southwest wall was 80x60 centimeters (2.6x2.0 ft.). The pier at the east corner was between these sizes. While these three piers were square or rectangle-shaped, the west corner pier was L-shaped, with the longer sides measuring 80x60 centimeters (2.6x2.0 ft.).

The piers contained both machine- and hand-made bricks, and the west pier included both types, suggesting that recycled materials were used or that the bricks came from more than one source. This finding leads to different possible interpretations. One is that the building materials were reclaimed as a cost-saving measure. Another is that the house, like the cement piers of Feature 14, was built somewhat haphazardly, possibly replacing wood piers with brick and using whatever brick was available.

Figure 54.
Feature 15, Mine Employee House

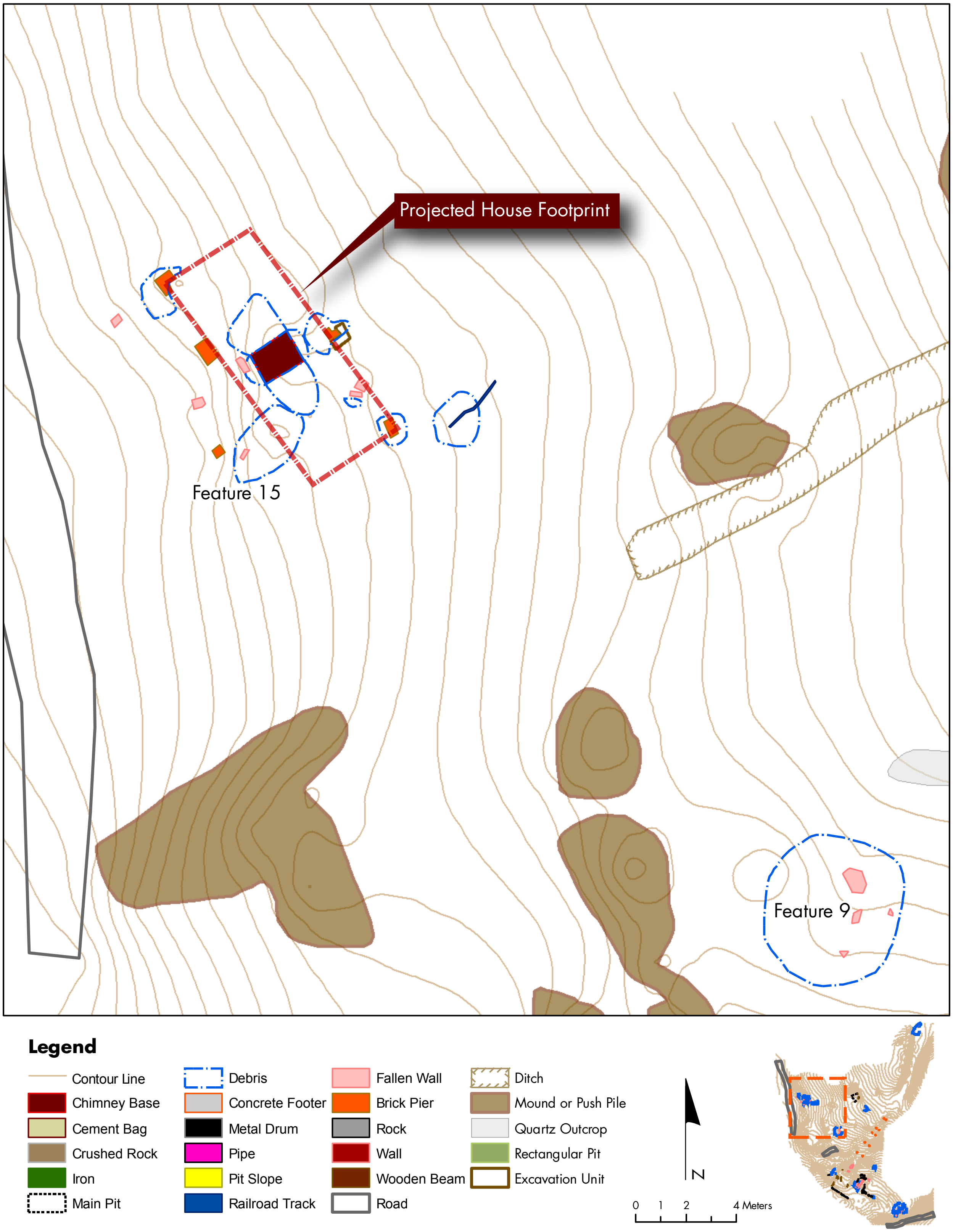


Figure 54.
Feature 15

A. View to the West with East Pier in Foreground. Hearth Side of Chimney is Facing the Camera.

B. View to the Southeast with West Pier at Right and Chimney in Center

The central chimney measured 1.5 meters (5 ft.) square and reached an extant height of about 50 centimeters (1.5 ft.) but was mounded with brick and other rubble. Cleaning and partial excavation of the mound indicated a single hearth facing southeast. The chimney rubble and hearth excavation produced 35 artifacts, among them quantities of architectural debris, particularly wire nails, and kitchen-related items (Table 4).

Table 4. Artifacts Recovered from Feature 15, Chimney Ruin

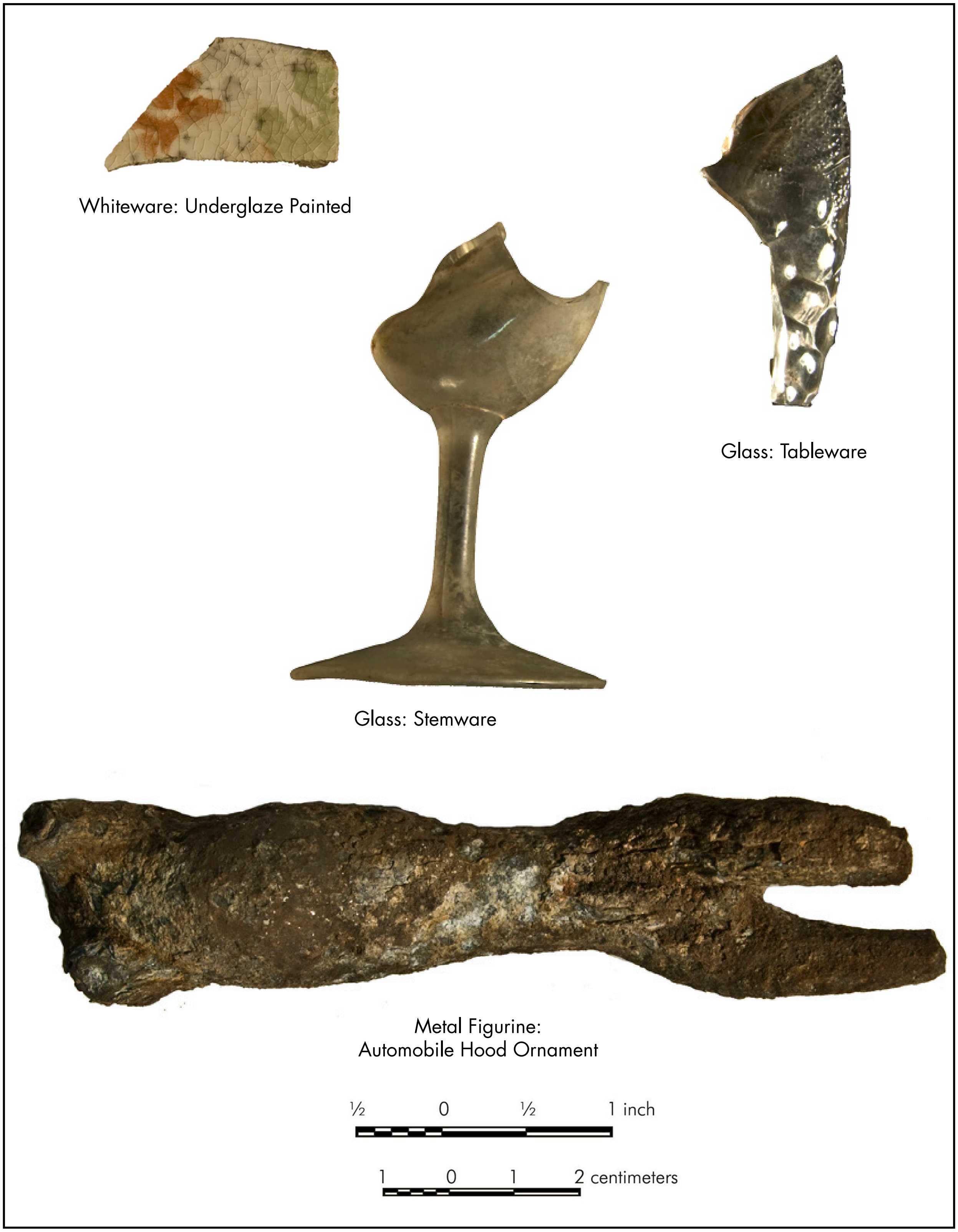
Artifact	Count
Auto Part, Metal hood ornament	1
Ceramic Industrial Item–Possible crucible/cupel	1
Container Glass, Clear	1
Iron/ Steel, Unidentified/ Corroded	5
Lead, Unidentified Melted	1
Nail, Unidentified Wire	15
Stove Part	1
Tableware Glass, Molded Stemware	1
Tableware Glass, Unidentified, Molded	1
Whiteware, Underglaze Handpainted	1
Window Glass	7
Total	35

Artifacts in the assemblage that could be dated include the wire nails, the whiteware, and the automobile part (Figure 56). The nails have a general date range from circa 1850 to the present, although they came into common use in the 1870s. While these do not provide a precise date, the absence of earlier artifacts such as cut nails, hints that the assemblage dates no earlier than the late nineteenth century. The whiteware also has a general date range of around 1820 to the present and so does not provide a clear date. The automobile part, however, dates to the twentieth century. This item consists of a molded metal figure of a leaping animal. The head and most of the limbs are missing, but it closely resembles the greyhound ornament used on Ford automobiles in the 1930s. This date is later than the last known use of the house and indicates post-occupation dumping or discard.

Additional domestic artifacts found with the chimney base included a burned glass stemware fragment and a molded glass vessel that could reflect food or beverage service or a decorative object. Five pieces of unidentified ferrous metal are curved and include two clear container fragments. A rectangular iron plate with a catch at one end and hinge at the other was tentatively identified as a stove part.

Finally, a container fragment from the chimney base was identified as a crucible or cupel (Figure 57). This shallow (approximately 10 mm [0.4 in.]) example measured 38 millimeters (1.5 in.) in diameter at the rim. The base was fractured and could not be measured, but it had nearly straight sides, indicating a similar dimension as the rim. The height was 19.5 millimeters (0.8 in.). The material of this item was indeterminate dense porous clay or bone ash. Cupels were used for

Figure 56.
Representative Artifacts from Feature 15, Chimney Base



assaying gold samples to monitor mining and milling processes (Hardesty 1988:38-39, 2010:105-107). The presence of a cupel or crucible at a domestic site could be incidental; they would be expected in association with an assay house, which according to Pittman (2008:i) was located a considerable distance to the northeast of Feature 15.

In addition to excavating part of the chimney base, New South placed a test window alongside the northeast pier to check its stratigraphy and sample artifacts. The test profile revealed a single deposit of very dark grayish brown (10YR 3/2) sandy loam that extended 20 centimeters (7.9 in.) to yellowish brown subsoil on which the pier rested. The extant pier reached six courses and 30 centimeters (1.0 ft.) high. The test produced a collection of 16 artifacts that included mainly domestic/kitchen-related items (Table 5).

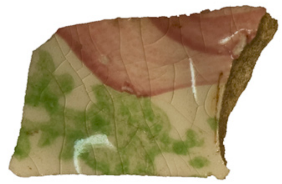
Table 5. Artifacts Recovered from Feature 15, Test Excavation

Artifact	Count
Canning Seal, Milk Glass	1
Container Glass, Aqua	2
Iron/ Steel, Unidentified/ Corroded	2
Stoneware, Alkaline Glazed	1
Table Knife, Metal	1
Whiteware, Plain	3
Whiteware, Decal	1
Window Glass	5
Total	16

Except for five fragments of flat glass and two indeterminate metal items, artifacts from the test unit were associated with food storage and service (Figure 58). Among these were an opaque white glass canning jar seal embossed “GENUINE BOYD CAP//FOR MASON JARS.” Boyd’s original patent dated to 1869, providing a beginning date for this item (Miller et al. 2000). The end date for this particular style of seal was not determined. Other artifacts with known dates include two plain whiteware sherds (post 1820), one whiteware sherd with a decal decoration (post 1880), and one plain sherd marked “CLEVELAND//CHINA//G.H.B. CO,” which was associated with Cleveland China Company and George H. Bowman Company between the 1890s and 1930s (Lehner 1988). This item provides the shortest manufacturing span of any of the recovered artifacts and is consistent with the proposed time that Feature 15 was occupied. This item could therefore reflect materials related to the household occupying the site. Excavation also produced the blade of a clip-point knife stamped “STAINLESS STEEL.” According to Miller et al. (2001:16), stainless flatware was introduced in 1921, making this item a likely post-occupation introduction to the site. Other artifacts included container glass fragments and one alkaline-glazed stoneware handle.

Figure 57.
Cupel or Crucible from Feature 15 (Three Views)

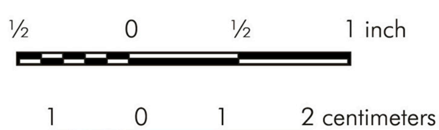
Figure 58.
Representative Artifacts from Feature 15, Test Excavation



Whiteware: Transfer Printed

Glass: Jar Lid Liner

Stainless Steel Knife



Although upon first examining Feature 15 its function was not obvious, the detailed inspection combined with artifact analysis and map data, indicated the feature reflected a house. Pittman (2008:i) illustrated two houses in this part of the site, one of which he lived in with his family, headed by his father Joseph Pittman who ran the boilers and engine for the stamp mill. Mechanic John Byrd and his wife occupied the other house. It is unknown which house Feature 15 represents. Disturbance in the vicinity of the feature prevented the identification of another house, if any remains of it were present.

Feature 5

Feature 5 comprised the remains of a brick structure located southeast of the stamp mill and partly buried below the abandoned segment of Haile Gold Mine Road. The function and identify of this feature was not determined and it was unclear how it related to the stamp mill.

The feature consisted of a segment of brick wall measuring 3.9 meters (12.9 ft.) long and one brick-length wide. At each end of the wall, iron T-bars braced it. The bricks were dry-pressed, suggesting a relatively recent date for the structure. (Gurcke [1987:87-88] indicated that pressed bricks were made as early as the 1820s, but did not go into common production and use until around 1900.)

The ground surface on the east side of the wall was equal to the wall's extant top while to the west it was lower and this depressed area was filled with brick rubble and debris that included articulated sections of brick wall and a wooden window or door frame. The wall segment and debris formed a feature measuring about 6x4 meters (20x13 ft.). Additional building rubble was scattered in the general area of the feature and 4.5 meters (15 ft.) north of the pile, there was a partly buried metal tank. The berm from the abandoned Haile Gold Mine Road segment lay southeast and partly covered the feature, indicating that the feature pre-dated this segment of the road.

The function of this feature was not determined by the fieldwork. Pittman (2008) and Nitze and Wilkens (1896) did not illustrate any structures in this area. Schrader's (1921) map of the pyrite operation illustrated a small boiler house in this general area, and it is possible Feature 5 is the remains of this structure.

Feature 6

Feature 6 encompassed a segment of metal pipe and two linked metal rods partly buried under the abandoned road segment. No investigation of this feature was made but its context suggested it comprised discarded refuse.

Feature 9

Feature 9 was a segment of articulated brick wall with a scatter of brick rubble. The articulated segment lay flat on the ground surface and did not comprise an in situ structure. Several large push piles or spoil dumps were located just west of Feature 9, suggesting the feature reflected secondary deposits or refuse dumping after the site's abandonment.

Feature 12

This feature was a rectangular pit measuring 2.7x1.4 meters (8.9x4.6 ft.) located northeast and up slope from Feature 10 (the reservoir). The feature reached a maximum depth of 50 centimeters (1.5 ft.). Its function was not determined.

Feature 19

Located northeast of the stamp mill, this feature consisted of a deposit containing cement bags (riprap-type with the woven or paper bags decomposed), rock, and miscellaneous metal and glass fragments. The feature measured approximately 3x3 meters (10x10 ft.) and was hand-cleaned enough to indicate it consisted of a single deposit on the ground surface. No evidence of a structure was found in this location, and the feature was interpreted as a dumpsite with no clear relationship to the stamp or pyrite mill.

Feature 22

Feature 22 was a pile of gneiss rocks located adjacent to Features 17 and 21. Measuring 3.6x1.4 meters (11.8x4.6 ft.), this feature contained rocks averaging around 30-40 centimeters (1.0-1.1 ft.) on their longest side. The rocks were not articulated and exhibited no evidence of mortar. They appeared to reflect a dump possibly abandoned at the end of the pyrite operation or placed during clearing after the site's abandonment.

FIELDWORK SUMMARY AND INTERPRETATIONS

Archaeological fieldwork at site 38LA383 involved primarily mapping and recording features representing the former stamp and pyrite mill along with associated features. The work delineated several features directly reflecting the mill and related functions, although in most instances the precise functions of these features could not be determined. However, the features provided information about the layout of the mill and its structural requirements.

Investigations revealed the general location of the stamp mill, engine house, and boiler house. Additionally, remains of the railroad line and ramp used to deliver ore to the top of the mill were recorded. The interior arrangement of the mill could not be clearly determined and extant remains did not clearly indicate if they reflected the stamp mill or the pyrite mill. Nevertheless, the general location and arrangement of features indicated the way the local landscape was used. The mill was built at the base of the ridge overlooking the creek terraces. Rather than building the mill into the ridge flank, which would have entailed considerable effort and expense to excavate and construct terraces, the mill's builders (probably under the supervision of Spilsbury in the 1880s) chose a relatively level spot at the base of the flank that required less extensive preparation.

This location still allowed the mill's design to incorporate a vertical organization that took advantage of gravity in moving materials downward and forward through the stamping and concentrating process. Building into a terraced slope was one way to accomplish this, while an alternative was to build a multi-story structure (a vertical mill) apart from a slope. This second alternative required that the ore be elevated to the top of the mill at the beginning of the process, as well as requiring extensive structural support. At Haile, the mill's designers solved the first consideration by placing the building adjacent to the ridge and extending the railroad line to the upper floor with a ramp. They further capitalized on vertical space by using the edge of an upper stream terrace (possibly with some augmentation) that allowed the concentrating house to lie at a lower elevation than the stamp room.

Another consideration in building a vertical mill on a flat site was the requirement for substantial foundations and framing to support the heavy machinery and protect against constant vibration. Building into the ridge flank would have provided greater support for the structure with a smaller investment into framing and foundation work. How the mill's designers and builders dealt with the problem of stability was not conclusively determined from archaeological investigations. The massive cement and wood structures indicated the effort put toward supporting some of the equipment and structural elements. However, no remains of a solid masonry foundation were identified. The only possible foundations were Features 1 (the wall surrounding the engine mounts), 2, and 18, and in general, these dry-laid stone features were not substantial or strongly built enough to handle the weight or vibration of the mill.

It appears possible that the mill incorporated wooden piles as a foundation. Feature 16/17 could represent such structures, although these could also be mortar blocks for the stamp batteries or supports for other equipment. Lock (1901:717), as noted, described the mill has containing a considerable amount of piling timber with no obvious purpose. In the context of Lock's discussion of back-to-back stamp batteries, the mill's use of piling timber might have made no sense, but the absence of significant masonry foundations at the actual site suggests that these pilings held the mill up.

These interpretations of the mill are complicated by the limited information on chronology. The mill went through at least three stages of development. Spilsbury first established the 20-stamp mill at this location. It is clear that this was the spot of that mill because when Thies took over the operation, he expanded rather than replaced the existing facility, first to 40 and then 60 stamps. The final stage of development came in the 1910s when the plant was remodeled for the pyrite operation. The relationship of specific features to any of these periods is not known, making it difficult or impossible to determine and understand who made decisions regarding the construction of certain features.

It can be assumed, however, that the mill's location and initial organization reflected Spilsbury's plans. Thies chose to expand the plant and apparently retained the concept of the vertical mill on a flat site. It is unknown what changes Thies made beyond expanding the size of the plant to house more stamps. The Kershaw Mining Company remodeled the mill, in the process removing the stamps and possibly the concentrating equipment and replacing it with the crushers, rollers, and jigs needed to produce pyrite concentrates. The only known changes to the buildings at this time were the addition of a bin or other structure on the north side of the mill, reorganizing the concentrating shed, and rebuilding the engine room. A new boiler house was apparently placed apart from the mill, possibly as a precaution suggested by the fate of the earlier one. This information is known from archival sources but the archaeological evidence at hand did not provide data necessary for understanding how each development period was reflected in the fabric of the site.

For instance, the massive cement structures represented by Features 1 and 7 cannot be attributed to any of the three principal development periods. Therefore, it cannot be said conclusively how different plant managers or designers decided to deal with the problem of stabilizing the mill's structures or equipment.

Feature 14, the cement railroad ramp footings, suggested other aspects of the site's development and the decisions regarding the level of effort and materials put into use. The variation in size, shape, and texture of these 10 footings suggests a rather unsystematic construction process and possibly different construction events. The more square ones implied the use of a form to shape them, while the oval and hybrid (rounded-squared) types appeared to have been shaped by the excavated posthole. The variation suggests that these were not installed all at once, but in two or more events, possibly as a means of shoring up an existing structure—maybe at the time the mill was rehabilitated for the pyrite plant. The variations in post size and shape, and the presence of attached planks and the nails in one example also imply the use of used recycled lumber. The explanations for this variation cannot be fully determined at present but suggest potential research topics for further study at other sites. In particular, it would be worth investigating how systematic or random were construction methods and other activities at mines or industrial sites in general at this time to understand how mining engineers of the time dealt with setting up, operating, and maintaining their operations.

Turning to the employee house, Feature 15, the archaeology revealed further variety in terms of the way the house piers were constructed. The brick piers exhibited different shapes and sizes, and at least one contained different types of bricks, indicating different sources of building materials and/or recycling. Further, inspection of the feature suggested that two corners of the house did not have brick piers. As discussed above, this finding implied that the piers were built at different times, possibly to replace wood footings. Another possibility is the use of second-hand materials as a cost-saving measure, which does not necessarily exclude the first possibility. The general feeling of this feature is of haphazard and piecemeal construction rather than being built or repaired as part of a systematic program using a single purchase of building supplies.

These possible interpretations have implications for understanding how the managers of Haile Gold Mine handled the logistics and supplies necessary for site construction. Based on documents, it is clear that Haile Gold Mine owned the property the house occupied and was probably responsible for its construction as well as of the village located elsewhere at the mine. It is not clear when the houses were built, although construction might have occurred during Spilsbury's tenure as manager and they were certainly in place by the end of the 1880s. It is also unknown if they were put up together as part of a single construction episode or if they were built as needed. What appears certain, however, is that repairs were made in response to particular situations. Maintenance was therefore expedient and did not involve overall improvements. The same could be said about the railroad ramp footings, suggesting a policy of making stopgap fixes in response to attrition or damage.

In summary, the fieldwork documented features at 38LA383, demonstrated the organization and operation of the mill, and provided information about the way the site was arranged with respect to the natural contours. Analysis of features also raised several questions that could not be completely addressed. In particular, the means of providing the mill with adequate structural support was not clear, although hypothetically it was done with wooden pilings. Certain features also suggested an unsystematic approach to maintenance at the mine, which has implications for understanding how the Haile Gold Mine and/or Kershaw Mining Company viewed their investment at the mine. Although the fieldwork did not provide data for drawing decisive conclusions about this site, its workers, managers, and ownership, the work did suggest topics for further research at other mining sites in the Carolinas.

VI. CONCLUSIONS

This data recovery project was conducted as part of the mitigation of effects of future mining at Haile Gold Mine in Lancaster County. Site 38LA383, representing the 1880s-1908 stamp mill and the circa 1915-1919 pyrite mill will be impacted by activities related to the resumption of gold mining. In consultation with South Carolina Department of Archives and History, a "creative mitigation" approach was taken to this project. The archaeological study was limited in scope, primarily to map and document surface features. A second phase of the mitigation will be the development of an archaeological context for gold mining in the Carolinas. This chapter discusses the results of the historical and archaeological project at Site 38LA383. The archaeological context is provided in a separate document currently in preparation.

The presence of site 38LA383 was known locally for some time before the site was officially recorded in the South Carolina archaeological inventory as a result of a 1990s Phase I survey of the Haile Gold Mine property (Pluckhahn and Braley 1993). Efforts to have the stamp mill site listed on the NRHP began during the 1970s, as indicated by documents on file at the South Carolina Department of Archives and History. The nomination process does not appear to have been formally completed and the site is not currently listed on the NRHP. To facilitate the mitigation process, however, Haile Gold Mine accepted the significance of this site and agreed to a data recovery without the intermediate Phase II evaluation.

Three principal research questions were developed to guide the historical and archaeological study of site 38LA383. Given that the site was known to represent a particular technical aspect of the overall mining operation, the questions dealt with sorting out the site's developmental history, content, and technology. The research questions, along with the answers derived from historical and archaeological study, are presented below.

1. What were the physical components of the pre-1908 stamp mill, which included the stamp mill itself, the concentration house, and the boiler and engine rooms? How did these components function together?

Archival sources indicated that the stamp mill complex included the mill, concentration shed, engine room, boiler plant, and small-gauge railroad line. In addition, Pittman's (2008) history of the mine indicated the presence of a reservoir at the site as well as workers' houses.

Archaeological investigations roughly identified all of these features, illustrating the arrangement and physical qualities of the stamp mill complex. Analysis of the features with respect to the local terrain and archival sources demonstrated that the mill's designers (probably Spilsbury and his associates in the 1880s) decided to build a vertical mill. Establishing a site next to a ridge flank, they eliminated the need to terrace the slope by building on relatively level ground at the slope's base. At the same time, they incorporated the adjacent ridge crest to elevate ore to the top of the stamp mill, allowing the use of gravity to move the ore forward and downward once it was delivered to the bins on the mill's upper floor. They also used the edge of the upper stream terrace to create additional vertical separation for the concentration shed.

Archaeology also showed that the plant was built on relatively insubstantial underpinnings. No evidence of a solid stone foundation was found, implying that the mill stood on wood pilings. The sense of a limited investment into structural support was also indicated by the railroad ramp leading from the ridge crest to the mill. Here, instead of deep piles or strong masonry foundations, the ramp was supported on posts with relatively shallow cement footings.

The overall function of the mill complex was clear from archaeology and historical data. The purpose of the stamp mill was to crush gold-bearing ore to sand from which free gold could be collected. The residue of this stage went through concentration to enrich the ore, which was then sent for chemical treatment. The function of the pyrite mill was mainly to concentrate ore into to a marketable proportion for shipment. Both the gold and pyrite operations occupied the same building with some modifications that were not clearly discernable with archaeology.

Archaeological features indicated the transportation system for delivering ore to the mill via small-gauge railroad, the general location where ore was broken up and concentrated, suggesting the possible rail spur by which concentrates were taken to the chlorination plant. Pyrite concentrates were taken away by truck, but the roads used for this were not clearly identified. Power for the operation was supplied by steam boilers and a Corliss engine. Feature 1 clearly illustrated the location of the engine and how it was oriented with respect to the mill, while no evidence of the boilers was found. Feature 5, situated at a distance from the mill, was interpreted as a possible boiler house associated with the pyrite plant.

2. Was there evidence of changing technology at the stamp mill?

The archaeological investigations did not provide any direct evidence of technological change at the mill. Moreover, documents indicated that while different methods and technologies were applied at the mine, the stamp mill remained relatively constant in how it processed ore for gold extraction, the only significant differences being the scale of operations. For the pyrite mill, the equipment was changed but because it was intended to turn out a different product, this cannot be said to reflect technological evolution.

3. The first stamp mill at Haile Gold Mine was a five stamp mill constructed in 1837, but the location of this mill is not known. Was it at site 38LA383 or somewhere else?

No remains of an early mill were noted at site 38LA383. Artifacts recovered or observed at the site generally had manufacturing ranges that were too lengthy to provide precise dates or they indicated late nineteenth- or twentieth-century dates. Moreover, historical documents, particularly the 1850 plat of the Haile property, suggest that this first mill was located southwest of site 38LA383 and on the opposite side of Haile Gold Mine Creek.

In addition to addressing these questions, the study raised additional issues that potentially could be applied at other sites. As discussed in the previous chapter, aspects of construction observed at the railroad ramp and workers' house suggested a haphazard approach to facilities maintenance. This has implications for understanding the economics of an industrial operation as well as the ideologies affecting its organization, construction, and appearance. For example, mining sites, and industrial buildings and landscapes in general, can portray cultural ideologies (Hardesty 1988; 2010); social and aesthetic principals, both at the corporate and social levels (Alanen and Bjorkman 1998; Greenwood 1998; Malone and Parrott 1998); corporate identity (Slaton 1996); and business or management styles (Heite 1992). Many of these topics are manifested in phenomena such as the layout, appearance, and use of space at individual sites.

At 38LA383, the archaeological remains hinted that the over-riding consideration was cost, expediency, and function rather than creating or reinforcing any aesthetic or social programs. This is noteworthy because of the renown that Haile Gold Mine possessed during the late nineteenth to early twentieth centuries. Further, given the knowledge and experiences of the mill's managers during this period, they were almost certainly aware of the kinds of aesthetic and social projects being pursued at industrial sites in the United States. It is possible that the reason for the finds at 38LA383 was that the stamp mill and concentrating shed comprised relatively routine technologies while the chlorination plant using the Thies system was the centerpiece of the operation. Another possibility is that the extant features reflect the pyrite operation rather than the gold mine. There may be other reasons for the finds that would require additional archaeological and historical research to discover. The loss of most of the Haile Gold Mine site to past mining indicates that such research would not be worthwhile here. However, the topic can provide a guide for designing research at other sites.

Another finding was the lack of substantial building foundations. This was surprising given that stamp mills had specific requirements for strength and solidity. The plant designers seem to have used wood pilings, although this was not strongly confirmed by archaeological evidence, and the reason for the absence of stone or masonry is not clear. In conclusion, this historical and archaeological study documented extant features of site 38LA383, put them into their historical context, and addressed certain questions regarding the site's content, organization, function, and development.

Moreover, the biographical information obtained about Haile Gold Mine not only provided a context for the extant archaeological remains, but also provided considerable detail about this historically important site. Haile Gold Mine was not just one of the richest mines in the Carolinas, but it was the scene of important innovations in gold mining and extraction technology. Unfortunately, except for the stamp mill site, the overall mining operation was lost to later mining activities and these technological innovations, along with other economic and social aspects of the mine cannot be studied archaeologically.

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APPENDIX A: ARTIFACT CATALOG

Specimen Catalog

County: Lancaster
State: South Carolina
Project: Haile Gold Mine Stamp Mill (2010)

State Site #	Prov Bag #	Catalog #	Excavation Unit	Vertical Location	Count/ Weight	Artifact Description	Field Date
38LA383	1	38LA383-1-1	Feature 15E	Level 1	1 (326.8g)	Auto Part, Metal, hood ornament	5/2/11
38LA383	1	38LA383-1-2	Feature 15E	Level 1	15 (239.9g)	Nail, Unidentified Wire	5/2/11
38LA383	1	38LA383-1-3	Feature 15E	Level 1	1 (1411.4g)	Stove Part	5/2/11
38LA383	1	38LA383-1-4	Feature 15E	Level 1	5 (6.3g)	Iron/ Steel, Unidentified/ Corroded	5/2/11
38LA383	1	38LA383-1-5	Feature 15E	Level 1	1 (4.9g)	Tableware Glass, Unidentified, Molded	5/2/11
38LA383	1	38LA383-1-6	Feature 15E	Level 1	1 (12.4g)	Lead, Unidentified , sprue	5/2/11
38LA383	1	38LA383-1-7	Feature 15E	Level 1	1 (2.9g)	Container Glass, Clear	5/2/11
38LA383	1	38LA383-1-8	Feature 15E	Level 1	1 (3.4g)	Whiteware, Underglaze Handpainted	5/2/11
38LA383	1	38LA383-1-9	Feature 15E	Level 1	1 (29.8g)	Tableware Glass, Molded Stemware	5/2/11
38LA383	1	38LA383-1-10	Feature 15E	Level 1	1 (47.4g)	Ceramic Industrial Item, Miscellaneous, crucible	5/2/11
38LA383	1	38LA383-1-11	Feature 15E	Level 1	7 (96.3g)	Glass, Unmeasured Flat	5/2/11
38LA383	2	38LA383-2-1	Feature 15D	Level 1 (0-30)	2 (12g)	Whiteware, Plain	5/2/11
38LA383	2	38LA383-2-2	Feature 15D	Level 1 (0-30)	2 (20g)	Container Glass, Aqua	5/2/11
38LA383	2	38LA383-2-3	Feature 15D	Level 1 (0-30)	1 (3.9g)	Whiteware, Transfer Print Red/Green/Purple/ Black Or Brown	5/2/11
38LA383	2	38LA383-2-4	Feature 15D	Level 1 (0-30)	1 (26.4g)	Canning Seal, Milk Glass	5/2/11
38LA383	2	38LA383-2-5	Feature 15D	Level 1 (0-30)	1 (4.4g)	Table Knife, Metal	5/2/11
38LA383	2	38LA383-2-6	Feature 15D	Level 1 (0-30)	2 (22.7g)	Iron/ Steel, Unidentified/ Corroded	5/2/11
38LA383	2	38LA383-2-7	Feature 15D	Level 1 (0-30)	1 (27.4g)	Stoneware, Alkaline Glazed	5/2/11
38LA383	2	38LA383-2-8	Feature 15D	Level 1 (0-30)	1 (14.3g)	Whiteware, Plain, 1890s-1930s ref: Lehner's Encylopedia of US Marks on Porcelain, Pottery, and Clay p. 96-7	5/2/11
38LA383	2	38LA383-2-9	Feature 15D	Level 1 (0-30)	5 (25.5g)	Glass, Unmeasured Flat	5/2/11
38LA383	3	38LA383-3-1	Trench 1, Feature 7	Level 1	1 (84.2g)	Bottle Glass, Coca-Cola, Straight sided bottle with '...DEN, SC' from Camden Coca-Cola Bottling Company. ref: Jeter, Paul. South Carolina Beverage Bottles 1880-1980. p. 42-44.	5/4/11